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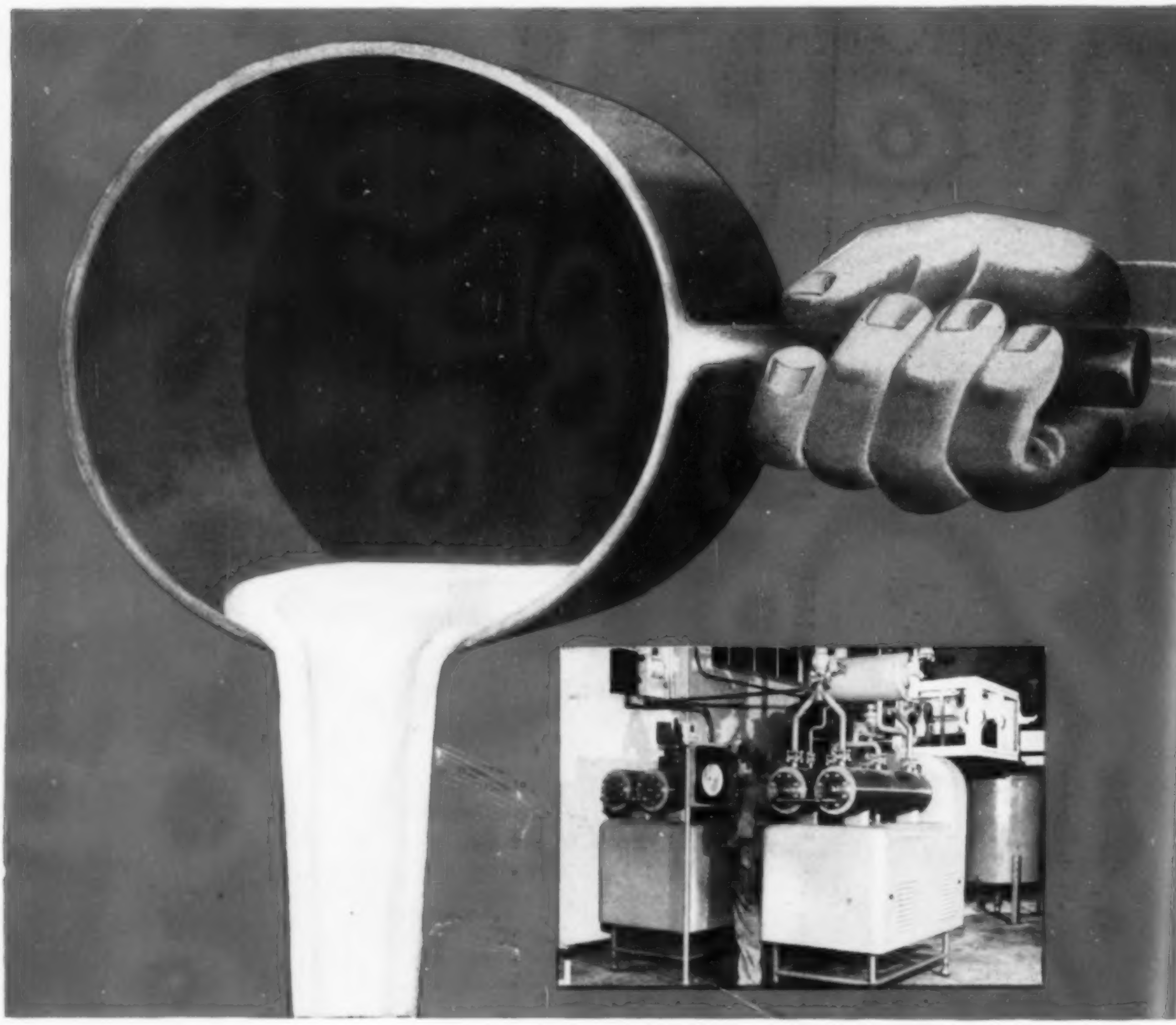
Materials of Construction for the Atomic Age

For NOVEMBER, 1946 • TWELFTH BIENNIAL REPORT ON MATERIALS OF CONSTRUCTION • HOW SPECIAL MATERIALS SOLVED CORROSION PROBLEMS AT OAK RIDGE • DESIGN OF LIQUID AGITATORS • EQUIPMENT COSTS • SOLVENT SEPARATION OF FATTY ACIDS



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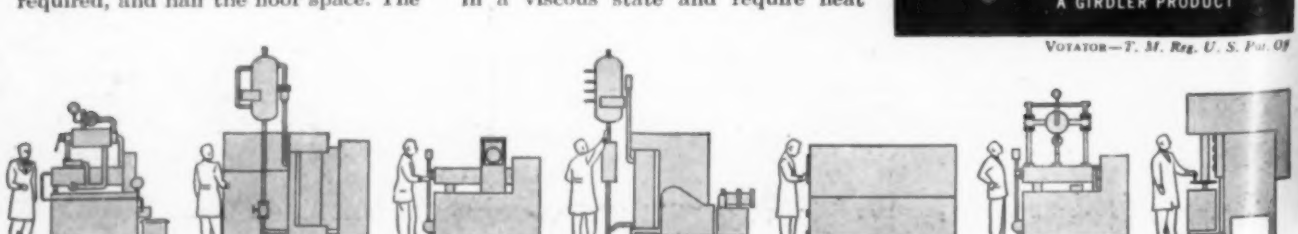


WATCHING WASHINGTON

R. S. McBRIDE, Editorial Consultant • D. D. HOGATE, Chief of McGraw-Hill Washington Bureau • J. V. HIGHTOWER, Washington Correspondent

Board appointed to make inventory of government research activities . . . Proposal to ban patent rights to civilians engaged in federally-financed research . . . Controls on rubber held necessary to insure production of synthetic . . . Voluntary allocation of soda ash in effect . . . Seized corporations in which enemy aliens hold interest poses patent problem . . . War plants disposal may pass from War Assets Administration . . . Fertilizer men want uniform state fertilizer regulations . . . Army produces ammonia at Ordnance works . . . International trade agreements aim at elimination of tariffs

SURVEY OF FEDERAL SCIENCE

Establishment by executive order last month of the Presidential Research Board headed by OWMR Director Steelman was a recognition of the need for starting, without further delay, an inventory of federally financed research and development. Truman's move is understood to be the result of urging by members of OWMR and Congress who want federal research to be civilian-dominated. They think research is taking on a strong military cast, perhaps merely because there is yet no coordinating agency. With the help of the 12-man advisory board composed of government officials Mr. Steelman is required to find out in detail what is going on, why, and where, and to file a report containing his findings and recommendations.

This is a job that might have already begun if the House had got around to and passed S. 1850, the Science Foundation bill approved by the Senate in the last session. It is expected in Washington that another effort will be made next spring to enact this or a similar measure. However, in the months before a national act could begin functioning and giving direction to the onrush of federal science, the need for an interim organization has become apparent. Mr. Steelman has been given the nod. If it becomes clear by next spring that science legislation will be stalled indefinitely in Congress, it is believed that Steelman will recommend establishment of a permanent executive agency.

A FACT-FINDING JOB

Steelman has received plenary authority to ask for and receive facts from all departments and independent offices. He is therefore placed in a position to study the extent to which government funds are being spent needlessly. Also, he should be able to determine whether there is building up an undesirable preponderance of research and development under purely military control. Steelman's job is basically a fact-finding, whither-are-we-drifting undertaking.

In issuing his order setting up the Research Board Mr. Truman said, "There must be no duplication, overlapping or inefficiency to hamper federal research." This was one of the premises on which the structure of S. 1850 was erected. The War and Navy Departments, both with burgeoning research and development programs, have set up a joint board to coordinate their work. There has been no equally tight coordinating group for all federal branches.

JUSTICE'S PATENT PLAN

Scheduled for White House attention last month was a Justice Department report recommending abolition of prevailing patent privileges accorded civilian organizations performing federally financed research and develoment. Justice would ban private patent rights in this field and substitute a policy of government patenting and selective licensing managed by a federal agency controlling all government-owned patents. Behind such a policy is the theory that it would be a helpful instrument in the Justice Department's antimonopoly tool kit.

This is a far more slashing proposal than the basic patent provision in the Science Foundation bill passed by the Senate but stalled in the House at the last session. That bill provided that, with certain exceptions under which private patents might be taken out, patents arising out of federally financed private research would be dedicated to the public. The Justice Department's plan would make such patents available only to those organizations acceptable to the federal patent agency. Washington offices which farm out research and which understand that the attractiveness of government contracts is greatly enhanced by the patent rights accorded organizations doing the work do not accord the Justice Department's idea a warm reception.

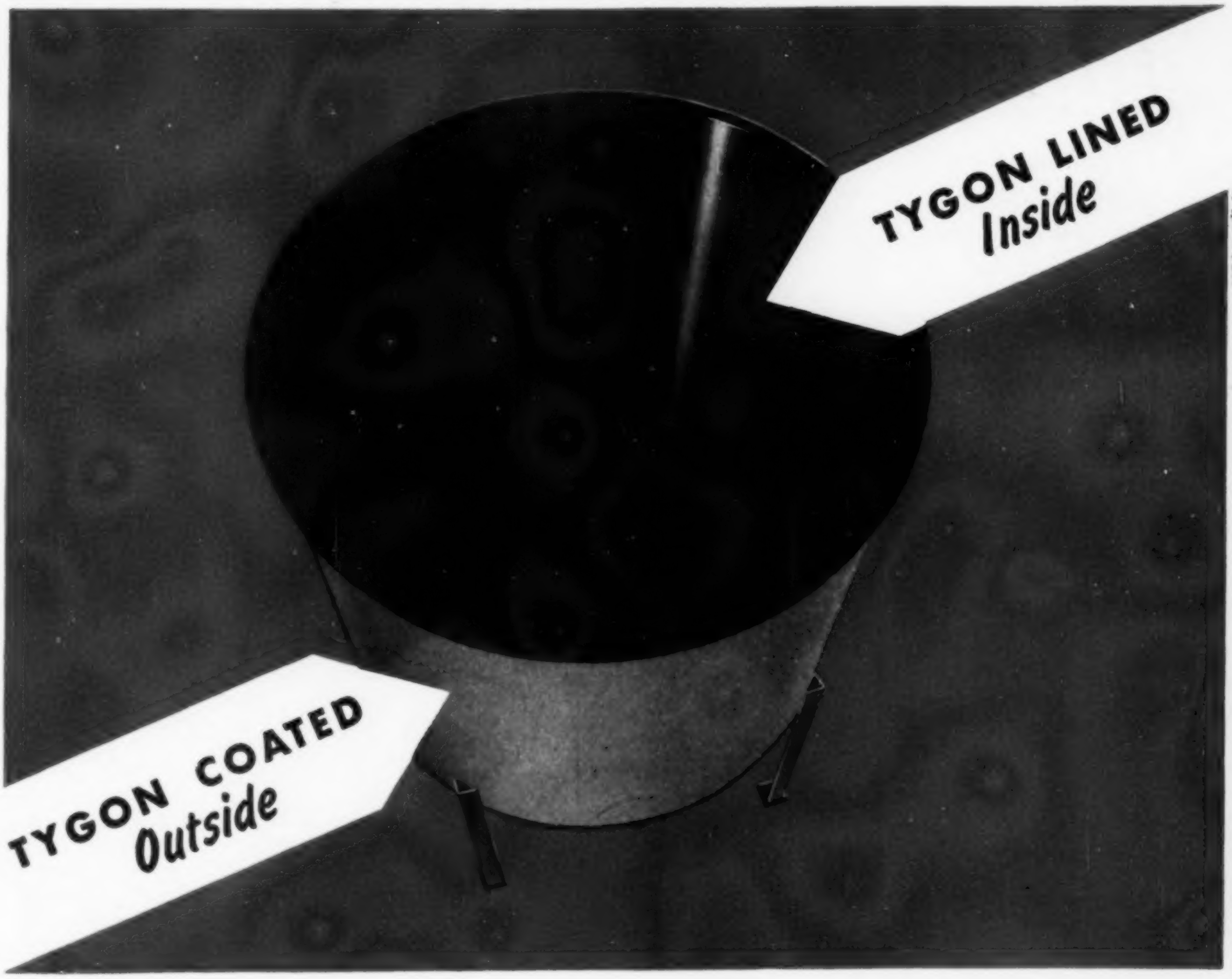
PRODUCTIVITY IS WHAT?

What can be done toward arriving at accurate, informative means of measuring and accounting for labor productivity is a live subject in Washington these days. As it is a growing factor in collective bargaining and the work of plant engineers, something is being done about it. The Labor Department is aware of the need for developing more illuminating facts than were formerly gleaned from productivity data on an industry-wide basis. Government agencies are being asked by labor and management to get those facts.

RUBBER DECONTROL UNLIKELY

Notwithstanding the scheduled lifting of international allocations of natural rubber on January 1 at the request of foreign producers, and the contracts for 20¼c. rubber negotiated last month in view of an improved outlook for supplies, rubber executives in Washington say the time has not yet come for abandoning the still existing domestic controls. They are particularly disturbed over the possibility of a sharp decline in the proportion of synthetic rubber in the total domestic new rubber consumption. Some officials estimate that this might eventually drop to 10 or 15 percent as compared with the present figure of 65 percent. Under specification rules likely to govern operations in the first quarter of 1947 it is understood that the ratio of natural to synthetic rubber will be held to about 50-50.

Despite the marked improvement in and current general acceptance of tires of the mixed rubbers the public, officials declare, is somewhat uncertain about these products. They suspect the uncertainty might be encouraged in a freely competitive market released from specification controls. They fear the results which such a development, if it persisted for any length



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Tygon plastic Paint is made from the same basic sheet stocks used to line the tank's interior. Applied in liquid form, Tygon Paint air dries quickly (by solvent evaporation) to form a tough, sturdy film of pure Tygon.

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U. S. Stoneware fabricates and installs a wide range of lining materials to meet highly specific conditions: Tygon plastic linings, Paraply rubber linings (natural rubber, GRS, or Neoprene), Republic sheet or homogeneous lead linings, Resilon synthetic linings, Acikote baked-on hard coatings. We'll be glad to submit suggestions, design detail, and specific recommendations as to the best material for your particular needs.

PLASTICS & SYNTHETICS DIVISION

U. S. STONEWARE

of time, would have on the general-purpose synthetic rubber industry. It is expected in Washington, that, regardless of the political complexion of Congress, strong support for legislation buttressing this industry will be manifested early next year. Belief is prevalent in the government rubber offices that a bill will stand a much better chance while the use of synthetic rubber is still obligatory.

RUBBER COMMITTEE CAUTIOUS

MEETING a few weeks ago with CPA, the Rubber Industry Advisory Committee was opposed to lifting domestic controls from rubber at present. This group recommended the temporary continuation of natural rubber purchases through the Rubber Development Corporation. Committee members also asked that specification and allocation controls such as exist in CPA Order R-1 should continue until at least March 31, and believed that similar controls will be required to protect the synthetic rubber industry after the Second War Powers Act expires on that date.

The advisory committee will study what type of legislation seems necessary to carry out the recent recommendations of the Inter-agency Policy Committee on Rubber. IPCR urges that at least a third of the annual rubber consumption, exclusive of specialty rubber, consist of general-purpose synthetic.

The 1947 program agreed upon last month by CPA and the advisory group is predicated on a consumption of 1,003,000 long tons of natural plus synthetic rubber. Of the total, 258,000 tons is first-quarter consumption, about half of which will be natural rubber. Estimates for the remaining quarters were not established.

ALIEN PATENTS FOR ALL

PATENTS resulting from the work of alien specialists engaged in civilian enterprise cannot be monopolized. This is one of the important conditions finally reached by the State-War-Navy Coordinating Committee with the approval of the Justice Department. The requirement is that such patents must be made generally available at "reasonable" royalties. Authorities in Washington say this condition is essential in order to avoid the charge that any agency of the government has been instrumental in importing foreign inventive genius for the sole benefit of a particular organization.

ALLOCATIONS FOR SODA ASH

WITH present production of soda ash about 15 percent below requirements of essential users, and no prospect of an early material increase in production, a voluntary allocation program was instituted last month by CPA and the Soda Ash Industry Advisory Committee. CPA has been unwilling to assume this function, but was preparing in October to issue a direction to Priority Regulation 28 whereby priority assistance is limited in securing soda ash for emergency cases or to increase production of critical products. A short time ago CPA was discussing with other government agencies the practicability of putting soda ash under export license.

Under the voluntary program efforts will be made to step up the delivery of soda ash to the aluminum industry by 45,000 to 50,000 tons yearly above current deliveries, in order to support maximum aluminum output for the housing program. In addition, it is contemplated that the requirements of vital uses of soda ash will be met. CPA officials say it is up to the soda ash industry to work out the details to govern deliveries for these and other uses.

There is little expectation that production of soda ash, which suffered heavy drops last May and June because of strikes, can be increased during 1947 by way of new manufacturing capacity recently authorized. CPA reports new construction authorizations to the Solvay Process Corp. for plants at Baton Rouge, La., and Detroit, Mich., and to the Wyandotte Chemical Co. at Wyandotte, Mich. Little or no construction on these projects has begun.

ASH EXPORTS INCREASE

INCREASED exports of soda ash to regions formerly supplied by other countries, as well as heavy domestic consumption by the glass, chemicals and non-ferrous metals industries, are contributing to the scarcity of soda ash. Exports of the product in the first eight months of 1946 are reported as 108 million lb. compared with approximately 102 million lb. for the entire year of 1938. Department of Commerce authorities point out that a number of countries which formerly took little or no soda ash from the United States are clamoring for a supply which we cannot furnish them. The collapse of production in Germany and Japan and the drop in production in England have brought about this condition.

JUSTICE GETS AN APC ISSUE

HAVING taken over the functions of the Alien Property Custodian last month, the Department of Justice has the job of making effective a decision of the Interdepartmental Committee on Foreign Economic Policy that patents held by corporations in which enemy aliens own an interest which has been seized should be opened to the public. Alternative steps would be to place such patents in the public domain or to license them on a royalty-free, non-exclusive basis as has been done with wholly German-owned patents.

When APC seized the enemy holdings of such organizations as American Bosch, General Aniline and American Potash, no action was taken on patents which they held. The principal reason was that destruction of the value of these patents would be unfair to American and friendly foreign owners of minority interests in the companies. The problem facing the Justice Department is how to go about opening up the patents on an equitable basis with respect to the minority groups.

SEE OIT FOR GERMAN PLANTS

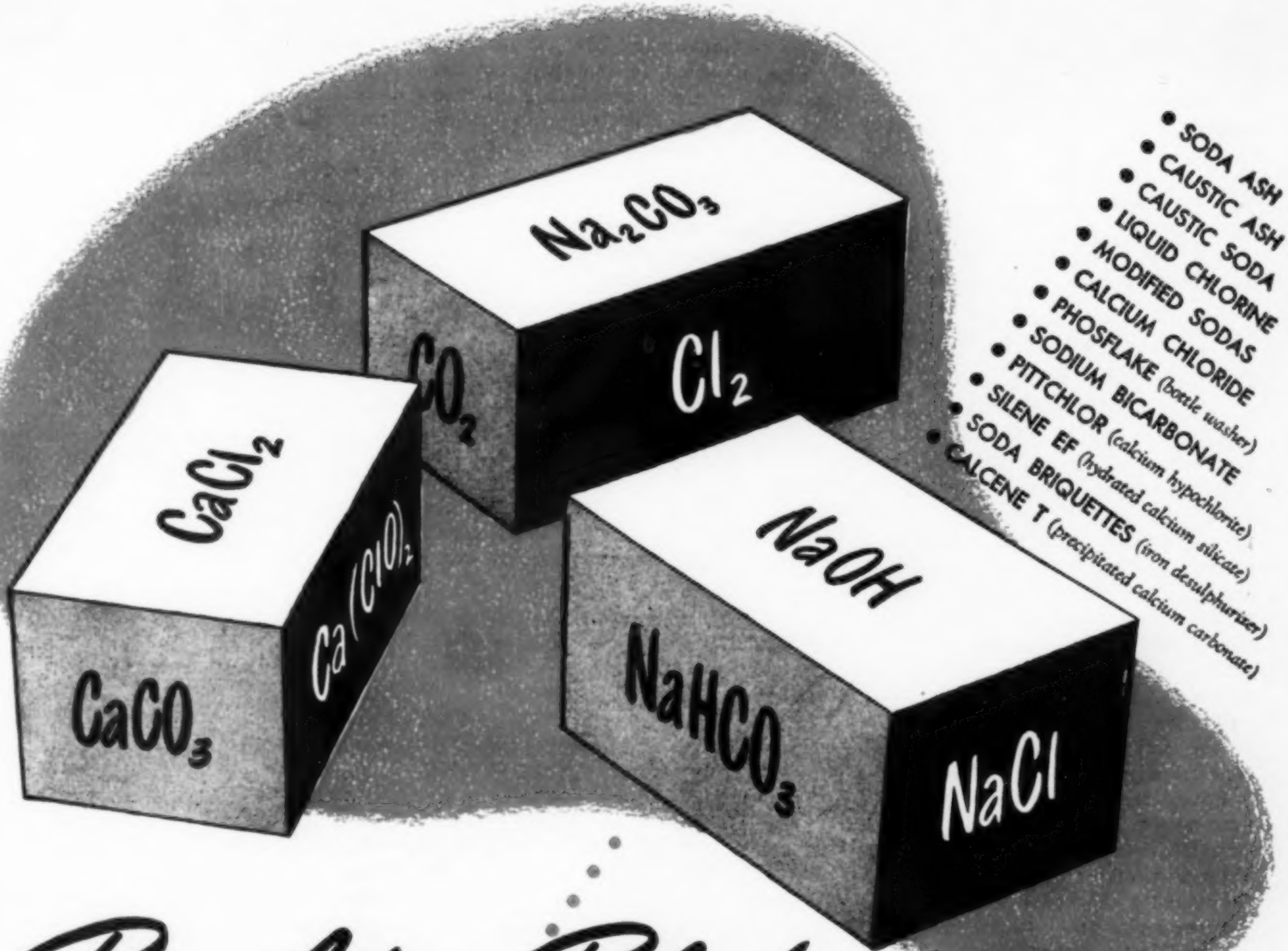
AMERICANS desirous of acquiring German chemical plants being declared available for reparations are asked by the Office of International Trade in the Department of Commerce for expressions of interest. Expressions of interest constitute no commitment to buy a plant if, as and when it is allocated to the American account by the Inter-Allied Reparations Agency. Plants or other facilities may be moved either to the United States or some other country. Such equipment, if acquired, cannot be left in Germany.

Acquisition of property, however, will not be an overnight matter. Thus far no policies or regulations governing the eventual transfer of reparations acquired by the United States to private concerns are established. Establishment of procedure is the task of the Office of Foreign Liquidation in the State Department. The work of designating the individual German plants available for reparations and the allocation of such plants among the claimant nations is still unfinished. Thus far about 40 chemical plants, including several I. G. installations, have been declared available for reparations.

WORK ON ALIEN ENTRY PLANS

HAVING worked most of the bugs out of a plan advanced last spring for making German and Austrian scientists and technologists available for American civilian enterprise, the State-War-Navy Coordinating Committee feels that it is now getting somewhere. As of last month decision had been reached to permit the presence, at any one time, of up to 1,000 of these aliens in the United States. With several hundred already here, it is believed the maximum contingent will be in this country by next spring. A majority of those in the list are slated initially for military assignments, although some are being imported as the result of requests filed with the Department of Commerce by industry and schools.

It is planned to release the foreign specialists to civilian tasks as rapidly as possible at the termination of their military assignments. However, there is a road block in the fact that the aliens, now entering this country under temporary status,



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These essential chemicals are aptly called "The Building Blocks of Industry," because without them products of modern Industry would not be the same as we know them today—and many could not be made at all.

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must be kept under military surveillance, which in effect limits them strictly to military work until their immigration status is clarified. Efforts were being made last month to reach a way out of the difficulty. Authorities close to this matter were confident of an early interdepartmental agreement whereby the specialists can be loaned to industry without surveillance during the period in which their eligibility for immigration is determined.

ORDERS FOR ALIENS

The agencies concerned with the continuing movement of German and Austrian specialists of exceptional talents into this country are bringing in a number who are not specifically slated for military work. These constitute a pool from which withdrawals for civilian assignments probably can be effected before the services of most of those with preassigned military tasks can be obtained. For various reasons it is desired to complete the movement at an early date. This objective, however, poses a problem: The undesirable prospect of feeding and housing a large body of unassigned aliens or those whose military tasks will end soon and leave them idle at government expense for an indefinite period.

Officials facing this problem are anxious for requests to be filed in Washington now for the employment of aliens of outstanding qualifications already in this country or still in Europe. The Office of Technical Services in the Department of Commerce is the agency with which requests should be placed. There is already a sizeable file of requests from universities, research institutions, chemical manufacturers and oil companies.

WAA TO HAND OVER BALL

Word from the vicinity of Congress is that War Assets Administration may soon be confronted with a demand that it hand over the battered ball of war plant disposal to some specially created agency, possibly called the Government Facilities Administration. The prospect is that such a proposal will taken form in the course of hearings scheduled to begin on December 10 before the Senate Small Business Committee. At that time the committee will begin to examine the record and try to determine what might be done about the glut of unmarketed plants.

As they stood last month the committee's plans call initially for a checkup on what has happened and is happening to the light metals plants, and then to shift to chemicals, petroleum refineries and other fields. In the course of this journey, it is understood the committee will launch some remarks about the need for a separate plant disposal agency, separately staffed from WAA, which, committee members feel, has a topheavy contingent of men who think in terms of commodities rather than plants.

In addition, there is exploratory thinking in the committee that a new disposal agency should consider the broad question of adequacy of production facilities in the various industries in which the government owns productive capacity. In such deliberation the agency would, in the thinking of some committeemen, dwell on the practicability and desirability of setting up rival "small" businesses as rivals to the "big" companies.

FERTILIZER OFFICIALS JOIN

A new fertilizer organization, the Association of American Fertilizer Control Officials, was established last month in Washington at the annual meeting of the Association of Official Agricultural Chemists. Interests of this group of state control officials are concentrated on national and state laws affecting mixed fertilizers and fertilizer chemicals with respect to labeling, standards and other regulations. One immediate objective is to accelerate the promotion of uniform state fertilizer rules on the basis of a new draft drawn up last month. Officials are headed by D. S. Coltrane, assistant agriculture commissioner of North Carolina, the president, and A. B. Lemon, chief of the Bureau of Chemistry, California Department of Agriculture, the vice president.

ARMY PRODUCING FERTILIZER

The War Department believes that its OWMR-directed program of producing 684,000 tons of fertilizer-grade ammonium nitrate in ordnance plants for shipment to Germany and Japan will be completed by next August. After four months of plant conversion work, the War Department finally got production of anhydrous ammonia under way in October at the Ohio River, Missouri and Cactus Ordnance Works, and planned to start production at the Morgantown Ordnance Works early this month.

Scheduled to begin this month the conversion of ammonia into ammonium nitrate solution were Indiana Arsenal, Joliet Arsenal, Radford Arsenal and the Sunflower and Wabash River Ordnance Works. Next month the Army expects the Holston Ordnance Works to be producing solution. The solutions are being or will be shipped this year to the following plants for graining, conditioning and bagging: Cornhusker, Nebraska, Illinois and Iowa Ordnance plants and the Milan and Ravenna Arsenals.

The War Department's program is intended to decrease and eventually eliminate the policy of shipping foodstuffs to the occupied areas, a policy considered by the State Department as essential for international political reasons until such time as those areas can improve their agricultural production.

PEORIA COB PLANT IN USE

Washington officials of the Department of Agriculture look for economically significant results from the operation, started last month, of the department's semi-commercial plant at Peoria, Ill., for conversion of corn cobs and other cellulosic farm wastes into alcohols. Saccharification by dilute sulphuric acid, followed by fermentation, the principles of which have been long established, is the heart of the process. Primary interest, dictated by the congressional appropriation for synthetic liquid fuels in 1944, is the production of alcoholic motor fuel.

Specialists in Washington say the importance of the work at Peoria resides largely in costs of manufacture. High yields of byproduct furfural are looked for and are expected to figure to a large extent in the economic attractiveness of results obtained in the semi-commercial plant. No significant operating results are looked for before some time next year.

FTC HEARING ON DYES

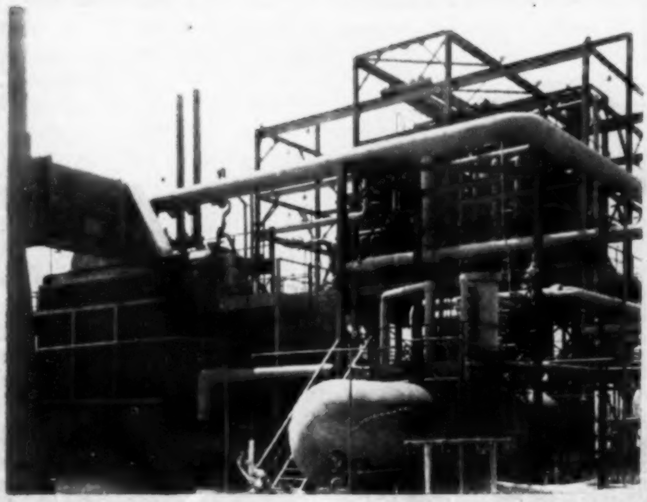
Following adoption in August of its new policy of industry-wide investigations the Federal Trade Commission last month scheduled for November 7 the first trade practice conference dealing with one of the chemical industries, household dye manufacturing and marketing. Decision to hold the conference resulted from several months of general investigation. The objective of this and all future conferences is to discuss the creation of a set of trade practice rules acceptable to the industry and subject to final approval by FTC. A Federal Trade spokesman said last month there were no other investigations under way in the chemical field.

HUNT FOR TANK CARS

In an effort to cope with the serious shortage of tank cars for chemicals the War Department, Office of Defense Transportation, and the War Assets Corporation set in motion last month a joint program to increase the supply of cars and improve efficiency of their use. The tank car shortage has been aggravated by reopening of ordnance plants for the production of nitrate fertilizers and by expansion of demand for cars to carry liquefied petroleum gases.

ODT is seeking to locate 525 petroleum tank cars capable of conversion into ammonium nitrate solution carriers. With a tough exchange job on its hands reminiscent of the war period, that agency is trying to replace cars taken from liquefied gas service either for commercial fertilizer

Dowtherm on the job!



Handling a big assignment in acid concentration

A battery of 30,000,000 Btu/hr. Dowtherm vaporizers supplies the heating requirements in this sulphuric acid concentration plant, built several years ago by a great Eastern firm. When the plant designers chose Dowtherm for this big installation, they simplified subsequent processing operations . . . and they also achieved a sizable reduction in the original construction costs of the plant!

Dowtherm was adopted because of its outstanding ability to combine high temperatures with low operating pressures. At a pressure of only 25 lb./sq. in. gauge, Dowtherm's temperature margin over the boiling point of the sulphuric acid was approximately four times as great as that of steam at 250 lb./sq. in. This advantage of Dowtherm cut down immensely on the heat transfer surface requirements . . . brought substantial savings in construction costs as a result. And the Dowtherm installation continues to pay dividends today in accurate, uniform heating with minimum maintenance requirements.

To users in many industries Dowtherm has brought a new experience in exact, low-pressure heating throughout the 300-725° F. range. It may point the way to new economies, greater product uniformity, and speedier production in your own processing operations! Dow's free booklet, "The Dowtherm Story," will give you the details.

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CHEMICALS INDISPENSABLE TO INDUSTRY AND AGRICULTURE

plants or the War Department as rapidly as production of new high pressure cars permits. The War Department's fertilizer program calls for the shifting of 280 cars in the anhydrous ammonia movement, and the withdrawal and conversion of 100 propane gas cars, in order to move ammonium nitrate solution. It is planned to replace most of these cars with the petroleum tank carriers which ODT is seeking. In addition to this shift-about program, ODT is trying to increase the efficiency of pressure cars by reducing cross-hauls and speeding turnaround time.

TRADE PLAN IDEAS OUTLINED

The American government's tentative ideas of the system under which the proposed United Nations International Trade Organization might function if that agency becomes operative next year have been outlined by the State Department. Released last month, the U. S. Draft Charter is the initial move to attempt to crystallize into a "constitution" the free trade principles which this country attached last spring to the British loan.

Ideas presented in the charter for an international trade group are couched in terms too broad to indicate at this time what effects such an organization might have on the American chemical industry. However, the charter contemplates the establishment of a world organization of nations agreeing to adopt a trade policy aimed at the eventual elimination of tariffs, customs, bi-lateral trading, state trading, etc., and the substitution therefor of international trade as free as that between the American states.

With customary caution the State Department emphasizes that the charter is not necessarily fixed American policy. Early next year the State Department will open the charter to public hearings. At that time domestic groups concerned with foreign trade will be asked for their views on the principles set forth.

ONR CHEMICAL SEMINARS

The Office of Naval Research, in an effort to bring about a closer relationship between ONR personnel and civilian scientists and technologists, has inaugurated a series of seminars in Washington for the discussion of research and development matters of interest to ONR. The series was launched last month with plastics as the subject. The plastics series, planned to extend over ten months, will include such subjects as synthetic lubricants, recent developments and applications of silicone rubbers, advances in laminated plastics and protective coverings. ONR has contracts with several universities and Goodyear Tire and Rubber Co. for plastics studies and expects to negotiate others. The Chemical Division of ONR has been working out a seminar on chemicals but has not yet disclosed the specific subjects to be covered.

FROM CATTLE TO COPPER

Washington during the meat famine got a new demonstration of the interdependence of modern industries. Cattle did not come to slaughter. Immediately there was a scarcity of inedible tallow for soap, of hides for the tanner, of numerous other byproducts for industries of great importance.

Then came the sequence of secondary and later events. This is one chain reaction: no cattle, no tallow, no soap-stock, no glycerine, no dynamite, no copper. This sequence actually became a controversial administrative issue; and serious effort had to be made about Washington to get mining and industrial explosives lest very vital housing projects be held up.

FPC GETS FINAL BRIEFS

The Federal Power Commission received a few weeks ago the last of a batch of briefs filed by the participants in the 11-month series of hearings before the commission on the subject of natural gas. The commission, according to opinion in and outside Washington, asked for these final rejoinders more as a matter of courtesy and form than as a means of helping the agency to make up its mind as to what changes in the Natural Gas Act it should seek from Congress. It is also thought that those who filed the briefs did so primarily out of the hope that when the gas fight opens next year, congressmen will be more likely to read and consider the final summaries of the petitioners than the voluminous testimony in the records of the hearings.

Gas industry men are convinced that FPC wants to get a declaration of Congressional policy on the competition between oil, gas and coal, and authority which would greatly extend FPC's present limited jurisdiction over natural gas. The natural gas industry has ready for Congress a program that would stop FPC from advancing a step beyond its present authority.

A SEARCH FOR CONTRACTS

Indications are that the military services, unless hampered by an era of economy in Congress, will for the next few years lay urgent demands upon private agencies for much research and development. In the aggregate the services would like to have a greater volume of contracts than they have thus far been able to place, largely with schools. The fighting agencies probably would do more work in their own shops if they were permitted to pay the kinds of salaries that are needed to secure qualified talent, but they lack this advantage. Accordingly they are looking, contract in hand, for outside help.

Contracts for research and development, rather than production contracts, have become the principal current concern of procurement and planning authorities. Army and Navy funds for basic studies have become almost half as large as money for procurement of materials and are much larger than they were before the war. The industrial mobilizaztion planners in Washington are determined to keep their plans supple and infused with the life of day-by-day scientific and engineering advances.

MINOR NEWS GLIMPSES

Silver bus bars, 16,300 tons of them, borrowed in 1942 for use in government war plants, are being returned to the Treasury from 13 plants which produced aluminum and magnesium and other scarce metals. RFC is returning the metal to the mints at Denver and Philadelphia and the Assay Office in New York City, where it will be recast into either coinage ingots or commercial bars. About 14,000 tons remains on loan to the War Department in the form of conductors at the Oak Ridge atomic bomb plant.

German chemical developments in detergents, emulsifiers, acetylene and pharmaceuticals continue to interest American chemical companies, which have sent their chemists and technologists to Germany this fall under arrangement with the Office of Technical Services, Department of Commerce.

Basic chemical industries, glass, and synthetic fibers as developed in the United States are interesting the Netherlands Indies government, which has sent Dr. D. R. Koolhaas, director of the Industrial Division of the Department of Economic Affairs, to this country. Koolhaas, stationed with the Netherlands Trade Commissioner in New York City, wants to learn about American methods and development which might be applied in the Netherlands Indies.

Unbalanced supplies of raw materials are causing much concern in many industries, and in Washington. Oftentimes the scarcity of one component or one reagent stops a whole factory. Some Washington observers think that this unbalance perhaps accounts for the very great recent increase in inventories of goods in process. There are no statistics to prove or disprove that interpretation.

Alcohol from wood will not be made at the new Oregon plant except on a small scale until the turn of the year. The government aid to that plant, which makes sugar from wood for fermentation, has not been enough to complete construction. A major delay has been caused by the lack of switches and starters.

CHEMICAL
ENGINEERING
WITH CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902 NOVEMBER 1946 SIDNEY D. KIRKPATRICK, Editor

Always Building, Never Built

IT IS almost axiomatic that chemical plant construction is a never-ending process. An industry that stems primarily from research is always changing and with increasing tempo as new processes and products call for improved construction to resist temperatures, pressures and corrosives never previously encountered. We enter the Atomic Age with many new materials and methods available for the chemical engineer's study and application.

When our first corrosion issue was published almost a quarter of a century ago, chemical equipment construction was largely limited to lead, cast iron, wood and stoneware. The chrome-nickel and other corrosion-resistant alloys made their appearance in volume shortly after the first World War. The late twenties and early thirties ushered in the era of the stainless steels, which soon found a multitude of new applications. With the forties came the ascendancy of the non-metallics—plastics and synthetic rubber, glass and porcelain, carbon and graphite—that have now greatly broadened the field of materials for equipment design and construction. So important have they become that in this twelfth in our series of materials of construction reports, the non-metallics, for the first time, take their place in the combined tabulations of reference data on availability, properties and applications. This year's directory presents, in all, more than 600 construction materials and is followed by a table showing their resistance to commonly used chemicals.

It is appropriate that this report should be introduced by a splendid article on the corrosion-resistant materials used in the electromagnetic plant of the atomic bomb project in Oak Ridge, Tenn. A look behind the doors in one of the world's most interesting plants reveals a variety of new materials in unique and daring applications. Less spectacular but sometimes as important as the materials themselves are the design and composition of gaskets that must withstand conditions of severest service in chemical equipment. This becomes the basis for a second useful contribution—an article that tabulates the general characteristics of both metallic and non-metallic gaskets and follows with recommendations for their selection and use in handling some 200 chemicals.

This country is now engaged in the biggest peacetime construction program in its history. In the six months ended September 26, Civilian Production Administration approved 52,000 applications for industrial buildings, estimated to cost just under two billion dollars. And the boom would have been half again as big had CPA not rejected 3,600 applications, worth \$1.4 billion. Some measure of what this program means to chemical engineers may be gaged by the fact that 50 of these projects in the process industries alone call for a total expenditure of \$180 million of which approximately \$130 million is for equipment and about \$50 million for buildings and structures. CPA, sated as it is with astronomical figures, is amazed at the size of the industrial program, particularly because it is coincidental with War Assets Administration's sale of some \$4 billion of surplus plants and facilities judged to have peacetime serviceability.

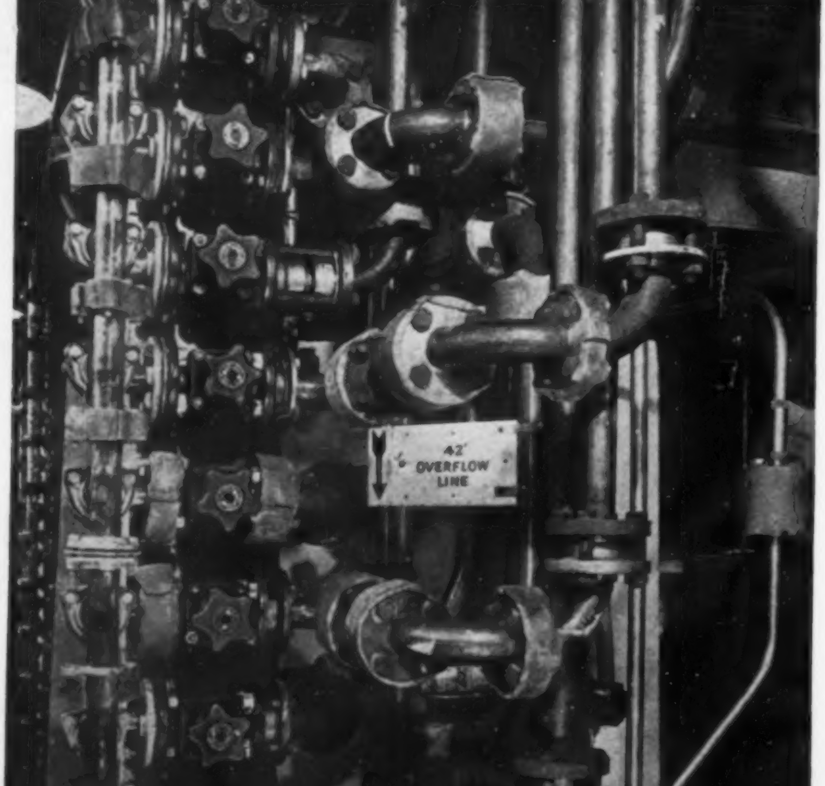
All of which adds up to the fact that the old is not good enough for the new plans and projects that are now coming from the research laboratories and drafting boards of the process industries. There is a big job to be done by chemical engineers in the days ahead and it is our earnest hope that this Twelfth Materials of Construction report will prove of practical help and inspiration in shouldering that heavy responsibility.

R. J. SCHRADER and A. De HAAN

Respectively Head of Chemical Engineering Department and Chemical Engineer, Tennessee Eastman Corp., Oak Ridge, Tenn.

Special Materials Solved CORROSION PROBLEMS

Production intricacies of materials for use in atomic bombs demand the most resistant materials of construction. Elimination of corrosion is a "must" not only for the prevention of equipment deterioration but for minimizing uranium losses. Many procedures developed especially for use at the electromagnetic separation plant of Clinton Engineer Works called for development of new alloys and non-metallic materials, and in addition special fabrication techniques. The valuable experience gained at Oak Ridge is applicable in almost every chemical plant. —*Editors*

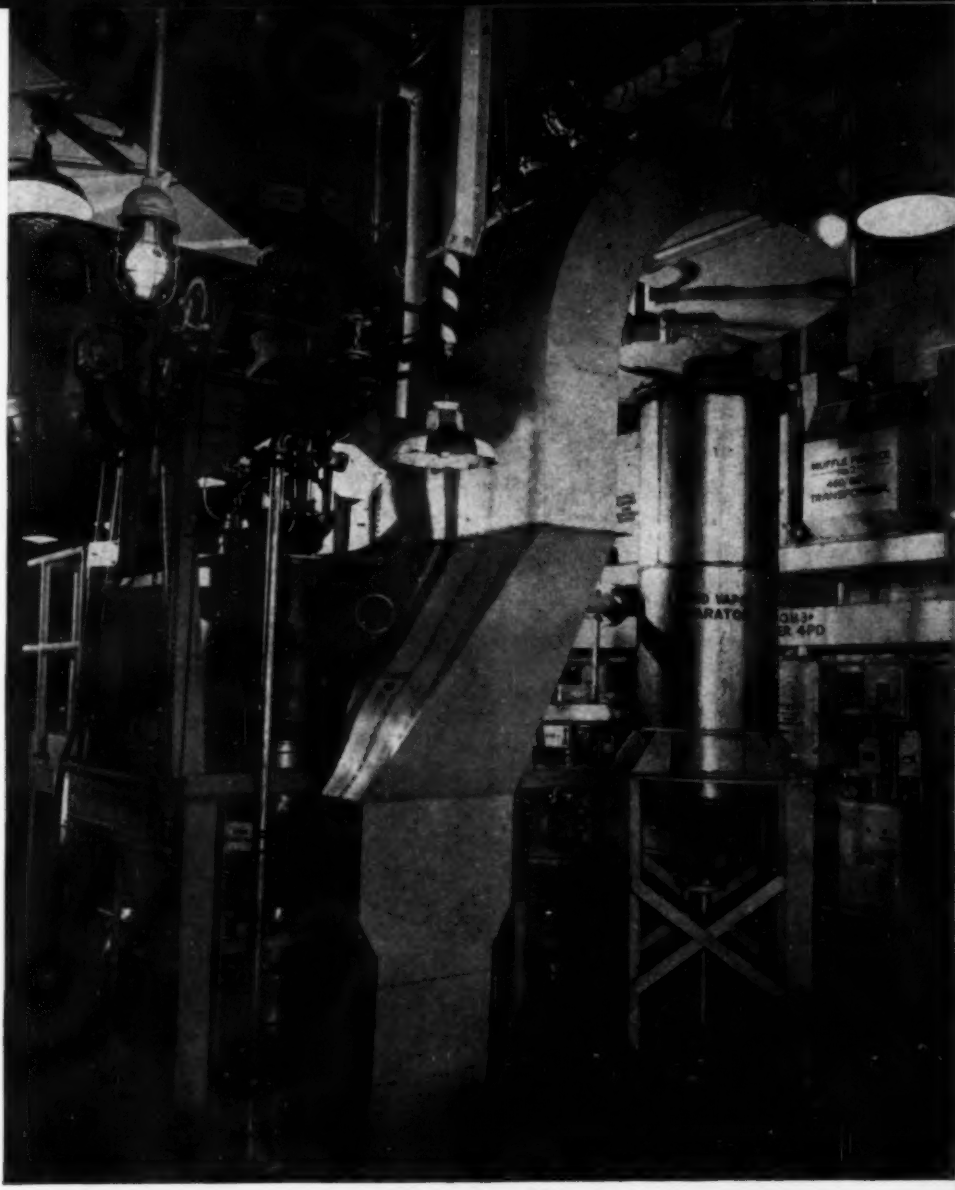


PREVENTION of corrosion is a major problem in the successful operation of the electromagnetic separation plant at the Clinton Engineer Works. As was described in the Smyth Report, calutrons (electromagnetic separation units) must be cleaned periodically in order to recover unresolved uranium which is scattered over the units and to condition them for another run. To insure complete uranium recovery a variety of cleaning solutions are used, several of which contain nitric acid and small concentrations of hydrochloric acid. These solutions are then processed in chemical plants to recover pure uranium salts which are used again as feed for the calutrons. Elimination or reduction of corrosion of both piping and equipment is important not only for the prevention of equipment deterioration but to hold losses of uranium, which invariably accompany spills and leaks, to a minimum.

Many desirable chemical procedures which were worked out in the laboratory during the past three years have been used successfully on a production scale only after the development of new materials of construction and special fabrication techniques. The problem of choosing the

Manifold header showing combination of Pyrex glass and type 316 stainless steel piping, using ferrule joints. Glass gives visibility. Joints are covered with lead shields for safety against sudden leaks that may develop.

at Oak Ridge



Solid bowl centrifuge installation with both Pyrex glass and stainless steel piping. Spot exhaust duct is of welded stainless steel construction

proper materials of construction has been extremely difficult since it was necessary in many instances to proceed simultaneously with both the laboratory research work and the design and construction of equipment. The choice of materials was further complicated by procurement difficulties and the tight time schedule on which new construction and plant modifications had to be made.

The cycle of operations in the chemical plant requires equipment which will withstand a large variety of corrosive conditions, such as nitric acid solutions of various strengths which contain chloride ion, highly oxidized acidic and basic solutions, organic solvents containing nitric acid, and acid fumes at temperatures as high as 1,400 deg. F. Materials of construction which are used under these conditions include inorganic materials such as Pyrex glass, porcelain, stoneware, Alberene, Karbate, Transite, and glass lining; organic and plastic materials such as natural and synthetic rubber, Saran, Haveg, Bisonite, Lucite, Teflon, Tygon, Silicones, and Koroseal; and metals such as stainless steels, Hastelloys, tantalum, silver, gold, Monel, nickel, platinum, Inconel, lead and lead lining, copper, and aluminum.

PIPING

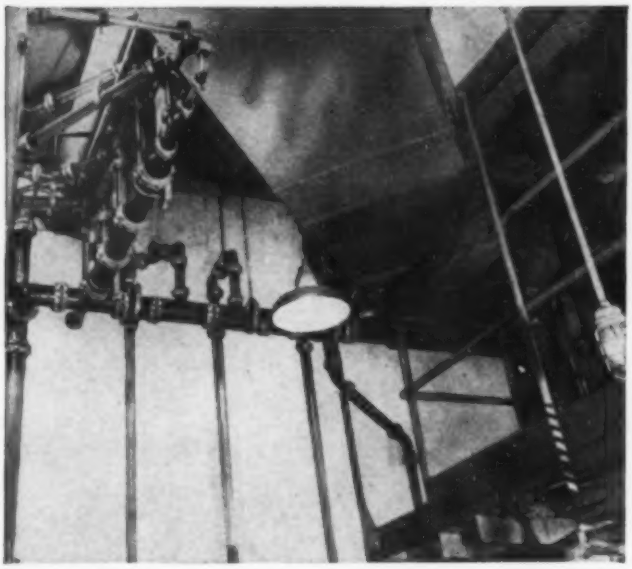
The complexity of the chemical operations carried on in the processing plants at Oak Ridge necessitated the use of almost every type of corrosion resistant piping known. In addition to standard materials such as stainless steel, many of the less common materials were tried and used on a greater scale than ever before. As a result, many new techniques of fabrication and installation were developed.

One of the standbys of the chemical process industries is stainless steel piping, and it was found again to be exceedingly versatile in its application. The main types of stainless steel used in process piping in the electromagnetic separation plant are types 302, 304, 316, 321, and 347. In the first installation, types 302 and 304 were used almost exclusively, and screwed fittings were widely used because of the ease of procurement and installation. Because of the difficulty of making many of the threaded joints tight, they were backwelded. This was a costly mistake because welding destroyed much of the corrosion resistance of the stainless steel and made any changes in the piping very difficult. Also, because of the high acidity and the chloride content of many of the process solutions, types 302 and 304 were attacked fairly rapidly. Consequently in all later installations type 316 stainless steel became standard for all stainless steel piping installations.

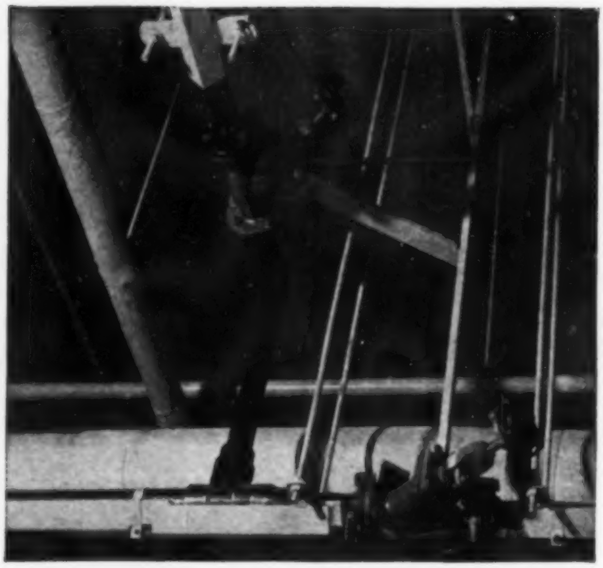
Type 316 is an 18-8 alloy containing about two percent of molybdenum which gives it considerable resistance to acid solutions containing small percentages of chlorides and to other corrosive agents. However, its austenitic structure tends to break down when it is heated in the range of 800 to 1,600 deg. F., and because of the resultant precipitation of chromium carbides along the grain boundaries, it becomes subject to intergranular corrosion. Welding, of course, produces these conditions so that extreme care must be taken to use either a non-weld method of fabrication or to carefully heat treat all welded pieces. Because of the limited furnace size available at Oak Ridge, the latter technique is only practical for the field fabrication of small pieces such as special tees and reducers.

FERRULE FITTINGS

The best non-weld construction found involves the use of ferrule fittings. The ferrule is a stainless steel ring which fits snugly over the end of a piece of pipe or tubing. Machined in the inner surface of the ring are two grooves about 0.015 in. deep. By using a standard type of pipe expander the tube or pipe is rolled into these grooves, thus joining the two pieces very securely by cold working of the metal. A standard carbon steel slip-on flange is



Glass pipe arrangement in a process building. Ductwork is Type 316 stainless steel non-welded construction



Section of Saran pipe used for deionized water showing method of supporting valves and piping

installed behind the ferrule. Using a suitable gasket, the two pieces of pipe are bolted together. This method is especially adaptable to field fabrication since the ferrules can be rolled on while the pipe is in position. It is possible to use either special ferruled fittings or standard flanged fittings with ferruled pipe. Because standard cast stainless steel fittings are less expensive, they are used whenever possible; ferruled fittings are fabricated only when special fittings are required.

In installations where the use of screwed stainless steel fittings is desirable or necessary, tinning the threads of the pipe and fittings before assembly has been found to be effective in obtaining tight joints. If no nitric acid is present, the use of litharge-and-glycerine pipe dope likewise aids in the prevention of leaks.

In those cases where corrosion is less severe, type 321 and type 347 stainless steel piping is used. These steels are stabilized against carbide precipitation with titanium and columbium respectively, and standard welded construction can be used.

The second major piping material used is Pyrex glass pipe, which was discussed in detail in the July issue of *Chemical and Metallurgical Engineering* (pp. 112–115). Glass pipe is used where stainless steel is not adequate or where it is desirable for the interior of the piping to be visible. Prior to the installations at Oak Ridge, glass pipe had been used only to a very limited extent, and most of this was prefabricated by the Corning Glass Works. On large installations it is often impractical in the time available to freeze the design and to make the piping layouts accurately enough to use prefabricated glass piping. Field fabrication also simplifies maintenance and minor alteration problems since it is not necessary to carry in stock very large numbers of special parts.

Primary considerations in the installation of glass pipe are the removal of all strains from it during fabrication and erection and the support and protection of the pipe after it is in place. The first requirement is accomplished by careful stress annealing of the pipe and fittings immediately after they are fabricated. Great pains are taken during the erection of the pipe to insure that no strains are introduced by misalignment or improper support. After installation, most of the glass piping is inspected for strains with a polariscope, and any strains that show up are removed with a portable electric annealing furnace. How well the stress relieving can be accomplished is indicated by the fact that all new glass pipe installations are tested hydrostatically at 100-lb. gage pressure. Most of the failures that occur during testing are at tees and other special fittings. Glass pipe should not be connected directly to equipment which vibrates considerably. Special flexible connections such as rubber or Tygon hose or flexible stainless steel tubing are used in these cases.

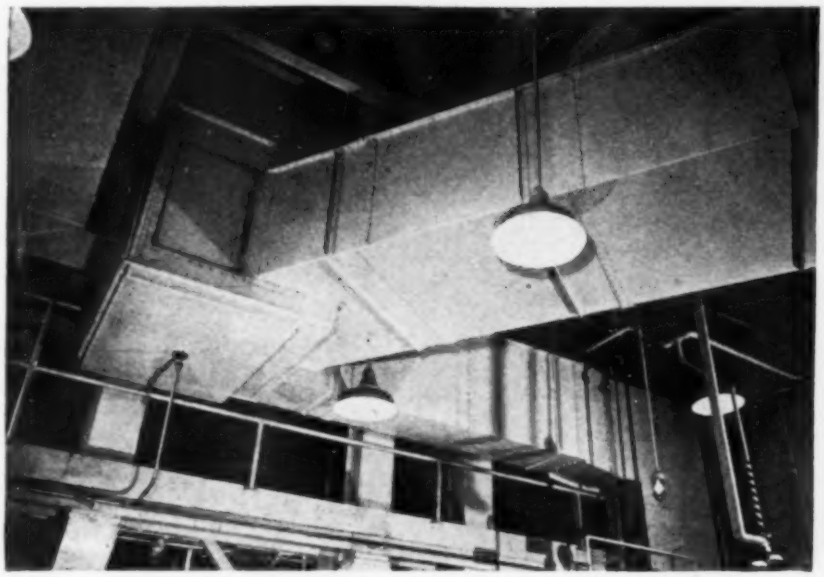
GLASS PIPE RESISTS SHOCK

The ability of glass pipe to resist shock when it is properly installed is remarkable. In the plant, very few cases of glass piping being broken during normal operations have occurred. However, care must be taken to protect the pipe wherever it runs in an exposed position near the floor. This can be done in most cases with a light angle-iron framework. Care must also be exercised to support all valves individually to prevent sudden stresses from being placed on the glass pipe while the valves are being operated.

Another type of special corrosion resistant material which is used to a considerable extent for piping are the Hastelloy alloys. Both Hastelloy B and C are used, depending on the particular conditions. Hastelloy B is used for solutions containing high concentrations of hydrochloric or hypochlorous acid and other chlorides while "C" is used where oxidizing agents such as nitric acid or ferric chloride are present. It is believed that position welding of Hastelloy pipe in the field was utilized for the first time in these installations. This was done by using an electric arc with Hastelloy welding rod. Previously, most Hastelloy was fabricated using atomic hydrogen welding.

Many thousands of feet of Saran pipe have been installed to carry distilled and deionized water throughout some of the large chemical processing buildings. Because of its low mechanical strength, horizontal runs of Saran pipe have to be well supported and must be reasonably free of any strain or the pipe will fracture under pressure. The cutting and welding of Saran pipe can be done very simply in the field. Welding is accomplished by merely softening the two pipe ends on a hot plate and then pressing them together.

Porcelain pipe has been used extensively in places where solutions containing high concentrations of both nitric and hydrochloric acids are handled. Porcelain pipe, although it can also be field fabricated, is not as versatile as glass pipe in this respect. Its mechanical strength is somewhat greater and it does not have to be protected as well. For use at Oak Ridge, however, it has few advantages over Pyrex pipe and several major disadvantages such as its nontransparency, lower resistance to heat shock, and greater weight which makes supporting it more difficult. For the most part, horizontal runs of porcelain



316 stainless steel ductwork, stainless bolts and Tygon gaskets are used at joints. Drain leg removes condensed vapors

pipe are supported in plywood or metal angles rather than with standard pipe hangers.

GASKET MATERIALS

Obtaining suitable gasket materials was one of the major problems at the time the chemical plants were placed into operation. The use of ordinary material such as blue African asbestos, rubber, compounded asbestos, and metal gaskets was totally unsatisfactory for many applications where corrosion conditions were unusual. For use with glass-lined equipment and Pyrex glass pipe, the gasket material must not only resist attack from the fluid being handled but also be sufficiently elastic to make tight joints possible without setting up strains in the piping or equipment. The most satisfactory material found for this service has been Tygon of medium hardness. This material will satisfactorily withstand attack of most mineral acids and oxidizing agents up to a temperature of 160 deg. F. The material would be even more useful if it could be compounded with fine glass cloth which would provide added strength and tend to prevent creep under pressure.

For use with metal pipe and equipment, we have found Teflon (polytetrafluoroethylene) to be the most satisfactory gasket material. This material will withstand aqueous solutions of mineral acids and oxidizing agents in all concentrations as well as a wide variety of organic compounds. Its upper temperature limit for use as a gasket material is 300 deg. C. Because of their hardness, Teflon gaskets are used chiefly with metal joints. Even though its initial cost is relatively high, the over-all cost is not prohibitive since Teflon gaskets may be reused a number of times. In special instances Teflon has been used satisfactorily in porcelain and Pyrex glass pipelines, although its use here is restricted because of the extreme care with which the piping must be aligned in order to obtain a tight but strain-free installation. Boiling the Teflon in water for 30 minutes just prior to its use in porcelain or glass pipelines has been found to aid materially in obtaining tight joints with lower flange pressures.

HIGH TEMPERATURE RESISTANCE

Many furnaces of the muffle type are used for incineration and calcining operations. These furnaces operate at temperatures ranging from 1,300 to 1,650 deg. F. in highly oxidizing atmospheres containing NO_2, SO_2, and small amounts of HCl. To facilitate the recovery of the incinerated material, metal furnace liners are used. Among the materials tried for this purpose have been types 309, 310, 316, and 347 stainless steels, Hastelloy C, and Inconel. Only those stainless steels containing a high percentage of nickel, such as types 309 and 310, have given reasonable service. Inconel liners have also stood up very well considering the extremely severe conditions.

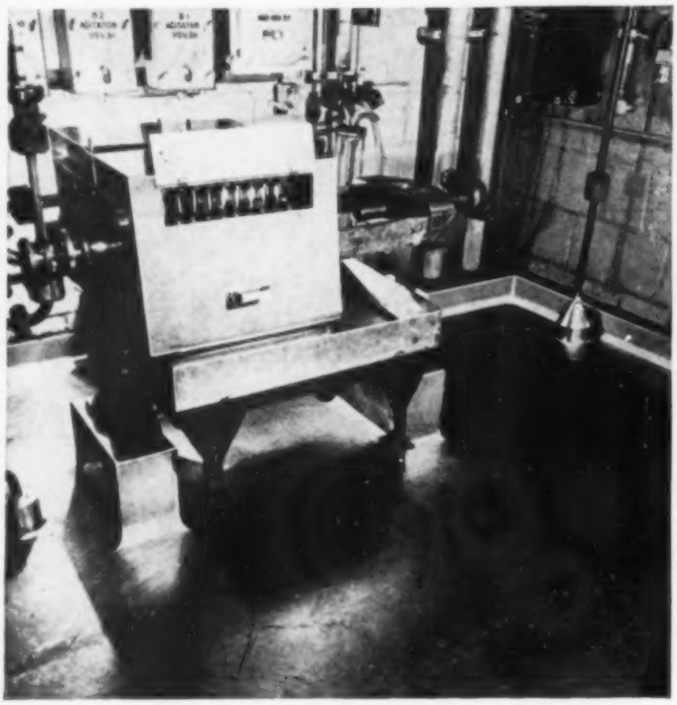
HIGH-SPEED CENTRIFUGES

Large numbers of Model 16 Sharples super centrifuges are used in the chemical plants for making sharp separations of immiscible liquids and of fine solids from highly corrosive solutions. These centrifuges consist of a small diameter cylindrical bowl which turns at speeds up to 15,000 rpm. mounted in a cost supporting frame. Because of the early delivery dates required, it was not possible to obtain centrifuges designed for use under severe corrosive conditions and standard centrifuges with cast iron frames were installed. It was found that a small amount of spray from the discharge of the centrifuge and leakage around the feed nozzle corroded the outer casting considerably. To combat this, a thin liner of sheet stainless steel was designed which could be slipped inside the casting and joined to the bearing assembly at the bottom to give a watertight enclosure. A trough around the top of the lining prevents solutions from leaking down between the casting and the liner. Other modifications to the centrifuges include replacements of the bronze drag bushing with one fabricated of carbon impregnated with paraffin and substitution of a stainless steel ferrule and Tygon ring for the brass bullet catcher assembly. These changes have made the standard centrifuges practical for use with many corrosive solutions.

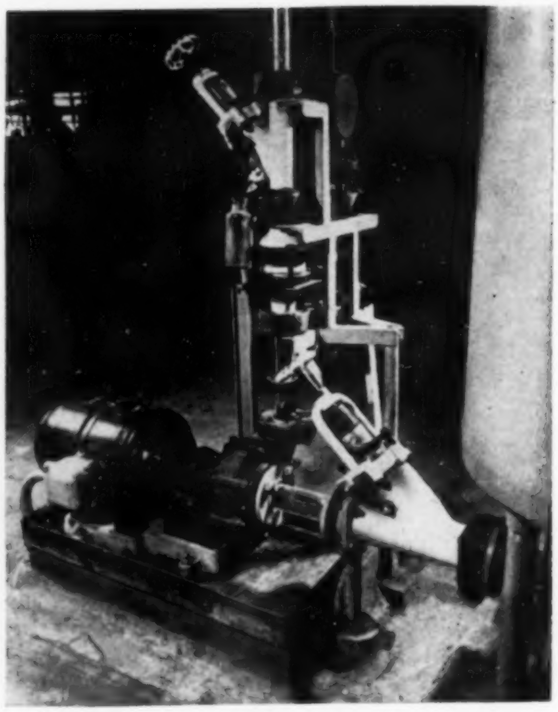
TANKS AND VESSELS

The majority of the tanks and vessels are fabricated of some type of stainless steel or are of glass-lined construction. For mild corrosive conditions or where no chlorides are present, welded tanks using type 321 or 347 stainless steel have proved entirely satisfactory. For handling acidic solutions containing appreciable amounts of chlorides, tanks constructed of type 316 stainless steel are preferred. However, these tanks must be properly heat treated to preserve the corrosive resistance of the welded parts. It has been found, from bitter experience, that the quality of the welds on equipment which is to be heat treated must be very high as any pinholes or slag inclusions will generally be exposed by the annealing and pickling procedures. Experience with unannealed tanks made of type 302 or 304 stainless steel has shown that the region around the welds will be rapidly attacked by copper, nickel, and iron salts in their high valence or oxidized state even in alkaline solutions.

With equipment where annealing is not practical because of warpage or other reasons, adequate resistance to corrosion under many conditions is obtained by giving the equipment a high polish. It is probable that where there are pits or imperfections in the metal a concentration cell is set up with the metal surrounding the cell becoming cathodic. This cell becomes extremely intense in good electrolytes, since the area of the effective cathode becomes very large as compared to the anodic pit. As a result the penetration may be much greater than would be the case in an unannealed area where carbides are present. That this is the case is borne out by the fact that the use of a commercial 4B or equivalent finish on unannealed, type 316 stainless steel equipment has in some instances given better service than equipment



Stainless steel filter press covers and stainless floor. Press is mounted on stainless steel covered pads. Special thimbles are used where piping runs through floor



Hard rubber centrifugal pump, glass piping and porcelain valves. Valves are rigidly supported to protect pipe from excessive strains

which has been annealed but not polished. Both annealing and polishing is, of course, preferable but the cost of this procedure is usually prohibitive.

For large volumes, glass-lined equipment was found to be the most satisfactory material for holding hot solutions containing high concentrations of both nitric and hydrochloric acids. Of course, glass-lined tanks and reactors must be well protected against mechanical shock and abrasion, but aside from this, the chief points of weakness are the plugs in the enamel itself. Minute imperfections in the lining are repaired at the factory by the insertion of plugs of gold or ceramic material similar to the way a dentist fills a tooth. This same method is generally used for the repair of failures in glass-lined equipment in the field. Under severe corrosive conditions, however, this method of repair has proved highly unsatisfactory because of recurrent failures at the plugs. Maintenance of glass-lined equipment was greatly reduced through the development and use of fracture plugs. In this method of repair a hole is drilled entirely through the glass-lined vessel at the point of failure, and a fracture plug is inserted in the hole. The head of the fracture plug is designed in such a manner that a line contact is provided on a gasket which in turn bears against the glass lining of the tank. The stem of the fracture plug which extends through the side of the tank is threaded and a bolt is used to compress the gasket between the head of the fracture plug and the wall of the tank.

Some ceramic vessels and towers have been used where corrosion conditions are unusually severe. As in the case of glass piping, installation and maintenance of ceramic equipment should be done by specially trained crews. In these installations care must be taken to avoid setting up strains in the equipment, and the installation must be well protected from mechanical shock and vibration. In some cases minor failures in ceramic equipment have been effectively repaired by coating the cracked sections with alternate layers of Permanite cement and thin glass cloth.

TANTALUM-LINED EQUIPMENT

One step in the chemical process involves the evaporation of a considerable volume of solution containing as high as 30 percent of nitric acid and up to 5 percent of hydrochloric acid. The only suitable material of construction found for evaporators under these conditions is tantalum, which is virtually unattacked by any mixture of these two acids. These evaporators are constructed with liners of tantalum, 0.013 in. thick, backed by heavy steel sheets. Although the tensile strength of tantalum sheet is high, its shear strength is much less so that considerable care must be exercised in the mechanical removal of scale from the evaporator parts. Chemical cleaning procedures are used for this operation whenever possible.

PAINTS AND PLASTIC COATINGS

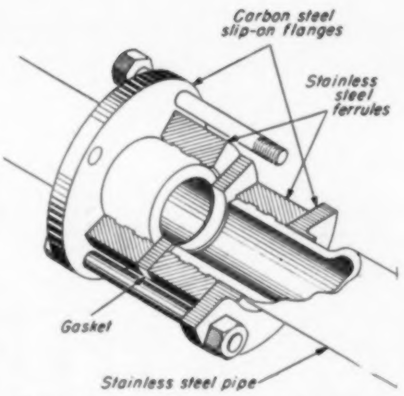
Various paints and plastics such as Tygon, Amercoat, Vita-Var, Bisonite, and Silicones have been used as protective coatings. For application on metal surfaces the main consideration has been found to be the careful preparation of the

Comparison of Estimated Costs—Typical Piping Installations

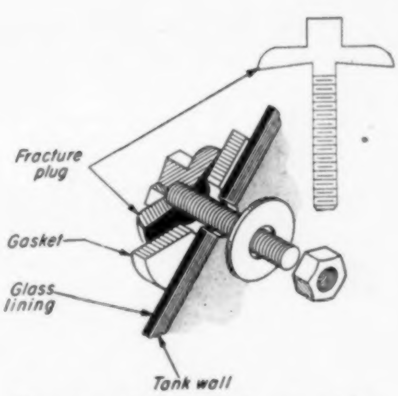
Type of Material and Method of Installation	Material	Labor	Total Cost
Screwed 316 stainless steel pipe, fittings, valves, and flanges	45	55	100
Flanged 316 stainless steel fittings and valves, stainless steel pipe and screwed flanges	86	68	154
Ferrule type 316 stainless steel fittings, standard pipe flanged valves	98	111	209
Ferrule type fittings on pipe only. Flanged valves and standard flanged fittings	84	86	170
Glass pipe and fittings with flanged glass lined, porcelain, or 316 stainless steel valves	39	122	161
Porcelain pipe and fittings, porcelain or 316 stainless steel flanged valves	40	103	143
Saran pipe, fittings and screwed 316 stainless steel valves	22	67	89
Wrought steel pipe with malleable iron screwed fittings, standard brass screwed valves	4	48	52

Note: All figures are based on the cost of 316 stainless steel screwed installations and labor costs were computed on the basis of $2.70 per hr.

surface to be coated by removal of dirt and grease and roughening by sandblasting. Silicone resins are promising because of the tenacious bond they form, even with polished surfaces. The use of plastic films or of oil base paints has been generally unsatisfactory in combating severe corrosion. Painted or coated ductwork installed for use in handling corrosive vapors has been attacked because of breaks in the bond with the metal. Factory applied linings of rubber, Tygon, and Bisonite for tanks and large fans have given satisfactory service in most installations because of their greater thickness and continuity.



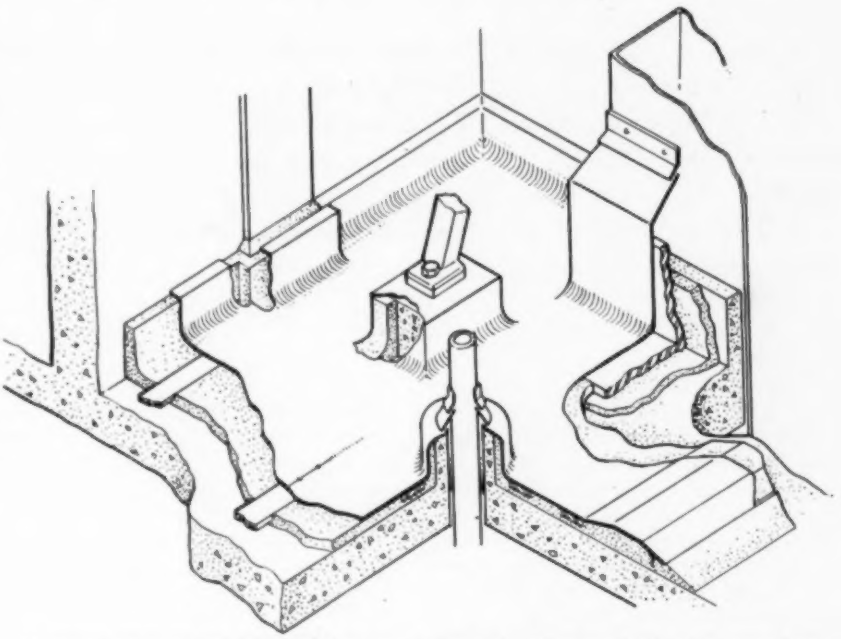
Typical ferrule joint used for type 316 stainless steel piping



Fracture plug used for repairing glass-lined equipment

HOODS AND DUCTWORK

Hoods and ductwork which carry acid vapors and other corrosive fumes are in most instances constructed of stabilized stainless steel, using welded construction where these metals are not attacked. Otherwise, type 316 stainless steel fabricated without welds, Tygon and rubber lined steel, chemical stoneware, and Alberene are used. Non-welded stainless steel construction, which is relatively expensive, consists of using flanged joints with Tygon gaskets. All ductwork installations are provided with drains from low points in the system which serve to remove any liquids which condense out. Hoods fabricated from Transite and periodically painted with Tygon paint resist the attack of mild corrosive fumes in analytical laboratories. For the severe attack of combined nitric acid and hydrochloric acid fumes, hoods are constructed of Alberene or stainless steel. For extremely corrosive service with hot condensing acid fumes containing fluorides, hoods are made of Karbate.



Cutaway view of typical stainless steel floor showing method of supporting it and way it can be built around various equipment

PUMPS

The materials most used for the construction of pumps are stainless steels and high-silicon irons, although Pyrex glass and rubber pumps are also used. The major problem encountered in the maintenance of pumps handling corrosive liquids is maintaining a relatively tight seal at the packing gland. The use of Duraseal type packing glands has proved satisfactory on pumps handling solutions which do not contain abrasive solids. A packing developed at the electromagnetic separation plant which has proved satisfactory for use in standard packing glands which are exposed to severe corrosive conditions is shredded Teflon mixed with a lubricant. It is not necessary for the lubricant to resist attack of the solutions being pumped since it acts primarily as a carrier for the Teflon chips. In pumps handling abrasive solids the use of Teflon spacers in the packing gland assembly is advantageous. These spacers are cut in the shape of washers and fit snugly around the pump shaft. In this way they form a partial seal around the shaft which helps prevent solids from entering the packing gland. Since Teflon is resistant to most inorganic acids and many organic materials, it approaches being an universal packing material for corrosive conditions.

CORROSION RESISTANT FLOORS

In areas where there is danger of floor contamination and where losses of uranium must be held at an absolute minimum special materials of construction for floors were used. Where there is no trucking or heavy traffic, such as in laboratories, Tygon flooring and heavy linoleum have proved satisfactory. Both are sufficiently resilient to reduce foot tiredness of operators who must stand on it for extended periods of time. The Tygen flooring in addition is not affected by many chemicals which attack asphalt tile or linoleum.

For production areas where the service is more severe continuous metal-clad floors are most effective in preventing losses. The problem of installing welded stainless steel floors which do not buckle and feel firm to the tread is solved by welding the stainless plate to backing bars imbedded in the concrete flooring. Sixteen-gage stainless steel with a 2B commercial finish is used for most installations. The backing bars are 2-in. by ½-in. carbon steel rods installed in the concrete with a maximum spacing of 24 in. One-quarter inch half-holes punched along the edge of the sheet at 6 in. intervals are used to plug weld the sheet to the backing bars. An ⅛-in. butt weld can then be made between the sheets and the welds ground smooth without danger of buckling the stainless steel. The areas covered with stainless steel are provided with curbing and thresholds which retain any major liquid spills within the area. All curbing, equipment foundations, and pipe thimbles are provided with cove bases which aid in cleaning the floor.

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Chemical and Heat Resistance of GASKET MATERIALS

Elsewhere in this special Materials of Construction issue there appears a lengthy compilation of data on the corrosion resistance of materials for general service. Gaskets, however, offer special problems in materials selection and must therefore be treated separately. Of the many factors which enter into the choosing of a gasket material, the two that are discussed here, heat and corrosion, are certainly among the most important.—*Editors*

SELECTING a gasket demands two decisions. What type of construction and what materials? The service factors which govern these decisions fall under two general headings, mechanical features of the joint and conditions of operation. These various factors are named in the accompanying outline. All have a direct bearing on the selection, and a change in any one can change the optimum construction or optimum materials of the gasket.

To give each of these factors the amount of attention it deserves would run to considerable length. Therefore, the scope of this article is limited; it is intended only (1) to skim briefly over the governing factors that are not going to be analyzed so there will be no misunderstanding about the nature and seriousness of the problems that remain; (2) to enumerate the gasket constructions in general use and to touch briefly on their applications; (3) to enumerate the ordinary gasket materials; and (4) to give detailed information on the two factors this article is really concerned with, namely, the heat and chemical resistance of the ordinary gasket materials. Thus, the only major contribution this article presumes to make to the literature on gaskets is the compilation of data on gasket materials versus heat and corrosion; the rest is offered more or less as orientation.

Outline of Service Factors Affecting Gasket Selection

- I. Mechanical Features of Flange
  - A. Bolting
  - B. Material
  - C. Surface finish of flange face (smooth, pitted, serrated, etc.)
  - D. Design of flange face (flat, raised, tongue-and-groove, etc.)
  - E. Dimensions
- II. Operating Conditions
  - A. Pressure
  - B. Cycle
  - C. Temperature
  - D. Corrosion

GOVERNING FACTORS

There are five features of the flanged assembly and four conditions of operation that influence gasket selection. This discussion will only name them and give examples of a few of the many ways they may limit the choice. The bolting available in an assembly sets the upper limit of gasket hardness since it determines the force that is available for seating the gasket or maintaining the seal at high fluid pressures. The material of which the flange is made has the same effect to the extent that some materials, chemical stoneware or glass-lined steel, for example, do not have the strength or abrasion resistance to withstand strong compression against a hard gasket. The surface finish of the flange facing also affects the permissible hardness of the gasket; both hard and soft gaskets are used with the smooth flat machine finish, but a soft non-metallic gasket is preferred for faces which are either roughened by service or deliberately serrated. The particular design of the flange face may best lend itself to, or even demand, a particular type of gasket. Thus, non-metallic gaskets $\frac{1}{16}$ in. thick or more give best results on the straight faced cast iron flanges common on low pressure lines; whereas the ring type joint, with its special shaped groove, requires the use of an all-metal gasket of special cross section. The dimensions of the flange face restrict the dimensions of the gasket of course, and since all gasket designs cannot be fabricated in all widths, diameters and shapes, the dimensions and shape of the flange contact face are further limitations on gasket choice.

Of the four operating factors which affect gasket selection, temperature and corrosiveness of the confined fluid are of much greater importance than pressure and the operating cycle. High pressures generally have the effect of requiring the use of a gasket which will fit one or another of the special flange face designs. If the operating cycle involves frequent alternation of high and low temperatures or alternate filling and emptying of the lines, it may be necessary to adjust the choice of gasket to suit these conditions. The two remaining conditions of operation which affect gasket selection, temperature and corrosion, are extremely important and will be discussed later in considerable detail.

GASKET CONSTRUCTIONS

All of the ordinary constructions used in the fabrication of non-metallic, metal-clad and all-metal gaskets are shown in Fig. 1. Leather, paper, cork compounds, rubber, plastics, compressed asbestos sheet gaskets, Fig 1 (a), and plain or treated thick woven asbestos gaskets, Fig. 1 (c), are generally satisfactory for ordinary service at low pressures and temperatures, the woven asbestos type being particularly suitable for rough, pitted or uneven surfaces and glass or glass-lined flanges. Round or special shaped gaskets, Fig. 1(b), molded from soft materials are useful in certain applications; round section metal gaskets have given excellent service in high vacuum installations. The plain corrugated metal

gaskets, Fig. 1(f), generally installed with a coating of gasket paste, and the asbestos-inlaid corrugated metal gaskets, Fig. 1(g) or (h), are used for relatively low pressures, the latter type being particularly suitable for rough or pitted flanges. The spirally wound metal-asbestos construction, Fig. 1(p), is suitable for all flange conditions, requires relatively light bolting, and is the most resilient of the metallic gasket designs. The metal jacketed asbestos gaskets, Fig. 1(d), are used for handhole openings and most small diameter closures of narrow widths. Fig. 1(e) is the standard double-jacketed metal-asbestos gasket for pipe flanges and heat exchangers, and Fig. 1(i) is a modification of this design, having improved resilience and requiring less bolting. The French type construction, Fig. 1(l) is used for valve bonnets, cylinder heads and vacuum service. A modification of this gasket using thick woven asbestos or rubber as a filler is finding extensive service in glass or glass-lined equipment. The all-metal gasket, Figs. 1 (j) and (o), have to a great extent replaced plain, flat metal gaskets because of their lower bolting requirements. The ring joint gasket, Fig. 1 (n), of oval or octagonal cross-section for use in ring type flange faces have found almost universal acceptance in the petroleum industry for all temperatures and pressures.

GASKET MATERIALS

All of the gasket materials ordinarily used in the chemical industry will be found either in the column headings of the long table which follows, or in the discussion below. This is the basic group of metallic and nonmetallic substances that industry has adopted for almost all its gasketing in corrosive services. Those applications not handled by one or another of this group require the use of gaskets of special composition, unless a welded or ungasketed joint will be satisfactory.

HEAT AND CORROSION IN GENERAL

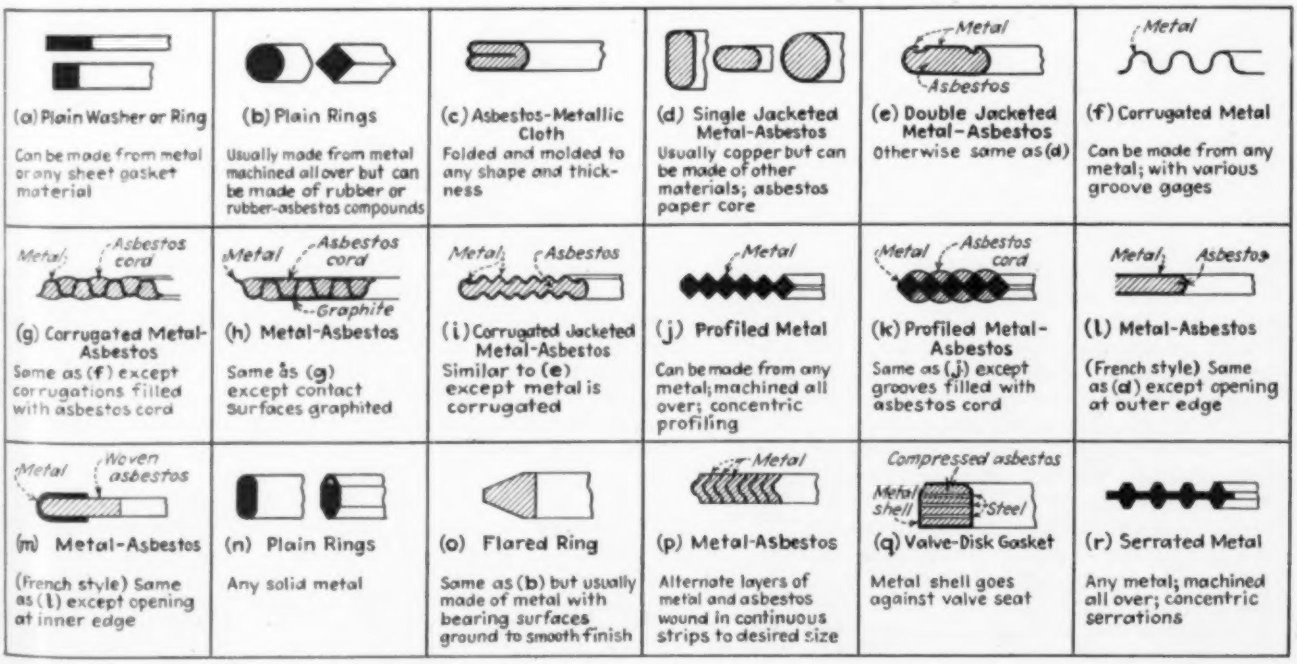
It might be assumed that a material suitably resistant in the form of a heavy reaction vessel would also be satisfactory as a gasket for the same conditions. Unfortunately, this is too often not the case. In the first place many materials do not lend themselves readily to fabrication in the form of gaskets, nor do they possess those basic physical characteristics requisite in every gasket design. The alloy cast irons, for example, are comparatively inexpensive and are ideal for some services, but they are too hard and brittle to be made into a satisfactory gasket. Then too, an all-metal or a metal-jacketed gasket is usually thin, highly stressed, and used in a location where turbulence is most likely to occur; a corrosive agent normally considered to have a low rate of attack may, when aided by the highly stressed condition of the metal and by the constant removal of any protective film by the turbulence at the joint, quickly eat through a gasket unless the material is almost perfectly resistant.

Thus, the selection of a gasket material suitably resistant to corrosive media or to high temperature involves a number of considerations that are usually inconsequential in selecting materials for other equipment. In order to predict with any degree of certainty the probable life of a gasket in corrosive or high temperature service the following factors must be carefully weighed. These are the opportunities for error. And at this time it should be stated emphatically that no compilation of data such as the table on pp. 106-109 could possibly take into account all of these variables; and to that extent the table is incomplete and dangerous. To select a gasket from the table without giving considerable thought to these other untabulatable factors is only asking for trouble. As evidence of the danger observe in the table the many instances where inability to define all these service details has led different manufacturers to make different recommendations.

1. *Concentration of Corrosive Agents*—Concentration of the corrosive agents may have a decided effect upon the selection of a resistant gasket material. Dilute solutions are not necessarily less corrosive than those of full strength, and the reverse is often the case. Probably the most familiar example of this is the action of sulphuric acid on iron; concentrations over 90 percent acid may be handled by iron without much difficulty, but below this concentration the rate of attack will increase rapidly with an increase in dilution.

2. *Purity of Corrosive Agent*—By purity, in this instance, is meant not concentration, but the absence of contaminating amounts of other corrosive compounds. For example, dissolved oxygen in otherwise chemically pure water can cause rapid deterioration of high-temperature steam generating equipment, and provisions are made to assure its removal from the feedwater. Another example would be the corrosive

Fig. 1—Gasket constructions commonly used in the chemical process industries



attack by compounds that are derivatives of an acid; in the pure state these compounds may be relatively inert, but if contaminated by any carry-over of free acid they must be handled with this in mind.

3. *Temperature*—In addition to its effects upon the mechanical properties of the gasket, the temperature of the corrosive agent will have a marked influence upon the rate of attack, particularly if the increase in temperature results in a boiling action that might tend to hasten the removal of protective coatings.

Gasket constructions, as well as gasket materials, have their temperature limitations. The non-metallic gaskets and those incorporating low-melting metals are, with a few exceptions, limited to service temperatures below 250 deg. F. The semi-metallic constructions, comprising gaskets made up of asbestos partially or completely clad with metal, may be used at temperatures up to 850 deg. F. Above 850 deg. only all metal gaskets are satisfactory.

4. *Location of the Gaskets*—Gaskets at or above the solution level may be more subject to attack than those at a point below the surface. Likewise, gaskets in horizontal runs of pipe that are periodically emptied or only partially filled in service, generally suffer more severe corrosion than those in lines that are readily drained or are kept full at all times.

In selection of a gasket for a highly corrosive service, it is often advisable to dimension the gasket as close as possible to the bore of the pipe or vessel to eliminate pockets and reduce local turbulence.

5. *Type of Gasket Construction*—The effect of this particular factor may not readily be defined and reduced to a simple set rule. Generally speaking, the expected rate of corrosion will govern the selection of the type of gasket. A gasket construction composed of a soft filler jacketed with a thin sheet of metal not perfectly resistant to attack might fail in a service where a solid design of the same metal would have a reasonable life.

Materials abnormally subject to stress-corrosion should not be used in a gasket construction that relies upon highly localized stressing to form the seal.

6. *Normal Frequency With Which Joint Will be Opened*—Here again the expected rate of corrosion should govern the selection of the material. If a closure is opened for inspection at frequent intervals any severe corrosion of the gasket would be readily noted and a new gasket could be substituted. In service of this nature a less resistant and possibly less expensive material might be suitable. However, for trouble-free operation of flanged joints that are to be in service for prolonged periods it is generally advisable to use a gasket completely resistant to corrosion, if such is available.

7. *Relative Cost of Materials*—Generally speaking, the cost of gaskets is so small that it is poor economy to use a material that may incur frequent and high labor expenses for necessary but otherwise avoidable replacement. However, if the joint is normally opened periodically for inspection, as was discussed in the previous paragraph, the labor charge would be the same, regardless of the gasket installed, and a less resistant material might be practical, provided of course that corrosion products in the process fluid were not objectionable from the contamination standpoint.

8. *Scrap Value of Gasket Materials*—In many instances the selection of a gasket material for a certain service may be reduced to a choice between an only partially resistant, but standard material, and a totally resistant, but initially expensive rare metal. It should be remembered that a portion of the cost of a rare metal gasket may be recovered in the scrap value of the material, which, together with the saving resulting from the increased service, may bring the total expense to a figure comparable with or even lower than that of the initially less expensive gasket.

HEAT AND CORROSION VS. METALLIC GASKETS

Lead—Lead shows excellent resistance to the action of many corrosive agents and finds wide application as a gasket in the chemical and allied industries where temperatures do not exceed that of boiling water, and the solutions handled are close to the neutral point. For higher temperature service up to 400 deg. F., the closure must be designed to prevent excessive creep of the gaskets.

Tin—Tin is useful where extremely pure neutral solutions and foods are handled. It is strongly attacked by acids and alkalis. Under some conditions it may be used at temperatures up to 400 deg. F., but is generally not recommended for service over 200 deg. F.

Aluminum—Pure aluminum is widely used as a gasket material, and its resistance to corrosion is due to the presence of a protective film formed either by oxidation or by the action of the aluminum with the corrosive fluid.

The protective coatings are attacked by strong acids and alkalis, but their resistance is sufficient to allow the use of aluminum in a variety of services. Because of its protective oxide coating, aluminum may be used at temperatures up to 800 deg. F. Its resistance to the hot sulphur-bearing gases encountered in the petroleum industry accounts for its popularity in this field.

Copper—Copper has excellent corrosion resistance and for this reason is, next to iron, the most generally used gasket material. The oxidizing acids, wet ammonia, and some strongly corrosive substances, such as chlorine, readily attack copper, as do sulphur and the sulphur compounds.

Copper is not recommended for gasket service at temperatures above 600 deg. F. This metal, unless it be deoxidized or oxygen-free, is also subject to embrittlement by exposure to hydrogen, carbon monoxide, and similar reducing gases at elevated temperatures.

Copper is not generally used as a gasket material in steel flanges if electrolysis can take place.

Brass—The common brasses act very much like copper in their resistance to corrosion. The high zinc alloys are subject to dezincification and in some instances to corrosion cracking, but proper selection of the alloy will guard against the former, and the latter may be eliminated by close fabricating controls.

Monel—Monel metal, because of its resistance to most acids, alkalis and other corrosive agents, both at normal and elevated temperatures, may be considered as one of the most versatile gasket materials.

Monel should not be used with the strongly oxidizing acids, such as nitric, nor with strong concentrations of hydrochloric acid. However, it is excellent for anhydrous hydrofluoric acid at elevated temperatures. Monel is subject to embrittlement when exposed to sulphur-bearing gases above 500 deg. F.

Monel may be used at temperatures up to 1,500 deg. F., under certain conditions. For steam service the upper limit appears to be approximately 800 deg. F., particularly for gaskets that might be subjected to stress-corrosion.

Nickel—Nickel does not have the all-around excellent resistance of Monel, but it does have definite advantages such as, for example, the ability to handle chlorine at temperatures up to 950 deg. F.

Nickel is subject to embrittlement by steam at temperatures above 800 deg. F., particularly if under stress. In oxidizing atmospheres this metal is useful up to 1,400 deg. F., and under controlled conditions may be used even higher.

Silver—Silver is resistant to alkalis, organic acids, and certain concentrations of hydrochloric and other mineral acids. Since its resistance to corrosion does not depend upon a protective oxide film, it may be used where such a film would be destroyed.

Wet corrosive gases, such as hydrogen sulphide, and the chlorine group, attack silver readily.

Silver may be used up to 1,200 deg. F., but must be reinforced at elevated temperatures to restrict creep of the material.

Platinum—Because of its initially high cost, platinum is used as a gasket metal only when no other material is available that will resist the corrosive action present. Platinum's low oxidation rate allows its use in ordinary atmospheres at temperatures up to 2,300 deg. F.

Ingot Iron and Low Carbon Steel (SAE 1010 to 1020)—Iron and low carbon steels are not suitable for handling crude acids or aqueous solutions of salts in the neutral or acid range. A high rate of failure may be expected for these materials used even in hot water service if the metal is highly stressed. Concentrated acids and most alkalis have little or no action on these materials, however, and iron and steel gaskets are regularly used for such services.

The upper temperature limit for iron gaskets is approximately 1,000 deg. F., particularly if the conditions are oxidizing. At this temperature steam will break down in contact with the iron and the rate of oxidation increases rapidly. Reducing gases carrying sulphur are strongly corrosive at temperatures above 600 deg. F.

Type 502 Chrome Steel with Molybdenum (4-6 Cr, 5 Mo)—This alloy, although not widely used outside of the oil industry, is particularly suitable for installations requiring resistance to oxidation at temperatures up to 1,200 deg. F. Its general corrosion resistance is somewhat better than iron. Its use at present is confined solely to ring-joint gaskets.

Type 410 Chrome Steel (11-14 Cr)—This alloy, because of its ability to resist oxidation at temperatures up to 1,300 deg. F., is used to some extent for certain specific gasket installations, but the 18-8 type stainless steels are generally more readily available, and in most instances would be preferable.

Type 304 Stainless Steel (Low Carbon 18-8)—This alloy is the standard stainless type chromium-nickel steel and it is used most extensively for gaskets under corrosive conditions.

Except for their inability to resist the attack of sulphuric acid and the halogens, particularly when wet, the 18-8 type stainless steels may be used in many services that cannot be handled by any other material.

The Type 304 alloy is made susceptible to intergranular corrosion only when it has been exposed to temperatures from 800 to 1,500 deg. F. for a length of time sufficient to allow the material to become unstable. In this unstable condition much of the corrosion resistance is lost and in addition the metal may become brittle. If the service in which the stainless steel is to be used involves a temperature above 800 deg. F., it is advisable to provide a gasket fabricated from a stabilized alloy, such as Type 347.

Type 347 Stainless Steel (Low Carbon 18-8 Cb Stabilized)—Stabilization of the straight 18-8 stainless steel by the addition of columbium raises the temperature at which the material can be used in continuous serice. Since intergranular corrosion does not take place in the stabilized alloy, it may be used safely up to 1,700 deg. F.

The addition of the stabilizing agent does not result in any appreciable increase in the resistance of the alloy to corrosion as compared to the Type 304, and its use as a gasket material is generally limited to services above 800 deg. F. where the unstabilized alloy would not be suitable.

Type 316 Stainless Steel (Low Carbon 18-8 with Mo)—The addition of approximately 2 percent of molybdenum to the straight 18-8 alloy increases its strength at elevated temperatures and results in somewhat improved corrosion resistance. This material is subject to intergranular corrosion if exposed to temperatures within the critical range of 800 to 1,500 deg. F.

HEAT AND CORROSION VS. NON-METALLIC GASKETS

White Fiber Asbestos (Chrysotile)—The common white asbestos is a mineral consisting essentially of magnesium silicate combinated with approximately 14 percent water of crystallization. In the pure form asbestos fiber has little strength, and for most gasket applications must be reinforced either with fine metal wire, if heat resistance is of prime importance, or with cotton for lower temperature service where softness is a factor.

Asbestos will retain most of its inherent strength up to about 900 deg. F., or just below a dull red heat. The loss of strength above 900 deg. F. is due to a gradual driving out of the water of crystallization. As the temperature goes above 900 deg. F., the rate of loss of strength increases rapidly, becoming almost instantaneous at 1,300 deg. F. Asbestos from which the water of crystallization has been driven by heating above 900 deg. F. may be reduced to a powder by merely rubbing the fibers between the fingers.

In the fabrication of gaskets, asbestos is used in two relatively pure forms, woven and as millboard or paper. In the woven form the asbestos is generally reinforced with both brass wire and cotton, and since the heat resistance is limited by the cotton content, plain woven asbestos gaskets are seldom used at temperatures above 300-400 deg. F., particularly if there is any considerable pressure to be held. Furthermore, since woven asbestos is very porous, gaskets of this type are usually impregnated with rubber or plastic compounds. Impregnation does not improve the heat resistance, as most of the compounds used are organic in nature and will themselves change in characteristics in the region of 200-400 deg. F. Asbestos millboard and paper are usually made up of relatively pure asbestos fibers bound with starch or sulphites. In gasket manufacture, millboard and paper are used as soft fillers for metal-jacketed designs, and allow use of these gaskets to temperatures up to 850 deg. F.

White asbestos has little resistance to the action of strong mineral acids. It may be used with weak acid and with most alkali solutions. This asbestos is seldom used as a gasket unless impregnated with rubber or sometimes a plastic, in which case the corrosion resistance of the gasket will depend upon the resistance of the impregnant as well as the asbestos.

Blue Fiber Asbestos (Crocidolite)—This material is widely used in the woven cloth form as an acid-resistant gasket for low pressures and relatively low temperatures. The temperature limit for blue asbestos is somewhat lower than for the white variety, and it is seldom used above 500 deg. F., unless reinforced or emloyed as an inlay in corrugated metal gaskets.

Rubber Sheeting from Nature Base Rubber—There are available numerous forms of rubber sheet material for gasket purposes. These forms vary in their rubber content and in the nature of their compounding. They have the general corrosion resistance of natural rubber compounds to the action of various chemicals, but are readily attacked by oils and petroleum solvents.

Rubber compounds will harden and become brittle by prolonged exposure to heat and are not to be recommended for gasket service at temperatures much above that of boiling water.

Synthetic Rubbers and Plastics—There are available gasket sheet materials compounded from innumerable synthetic rubber and plastic bases. Depending upon the base and the compounding used, a material suitable for almost every corrosive servive may be had. These sheet materials are in most instances limited to low-temperature service and only a few may be used above 250 deg. F., which appears to be the useful limit. The recently developed silicone compounds are said to be useful as high as 575 deg. F., but because of their scarcity their current applications have been rather limited.

Asbestos Composition Sheet—This most widely used gasket sheet material is actually a rubber compound with a high percentage of asbestos fiber as filler. The resistance of these asbestos composition sheets to corrosive agents and to temperature are determined by the nature of both the asbestos and the rubber compound. For most services the natural or reclaimed rubber base is used; for oil and certain chemical services, special bases must be specified.

For continuous service, asbestos composition sheet is used at temperatures up to 850 deg. F. Rubber base materials used at high temperatures become very hard and brittle and they cannot be re-used.

Chemical Resistance of Gasket Materials

Resistance Ratings[1]
A = Good
F = Fair
C = Depends on conditions
X = Unsuitable

CAUTION: Do not use table without reading footnotes and text.

Metals

Chemical	Lead	Copper	Aluminum	Monel	Nickel	Iron and Steel	Stainless 304	Stainless 316	Stainless 347	Others with good resistance[9]
Source of data[10]	G	G	G	G	G	G	G	G	G	G
Acetic acid, crude	X	F	F	F	F	X	—	F	—	Ag
pure	F	F	A	A	F	X	F	F	—	Ag
vapors	X	F	C	F	F	X	F	F	—	Ag
150 p.s.i., 400 deg. F.	X	F	C	F	F	X	—	F	—	Ag
Acetic anhydride	X	X	A	A	—	C	F	F	F	Ag
Acetone	A	A	A	A	A	A	A	A	A	
Acetylene	A	C	A	A	—	A	A	A	—	
Air	A	A	A	A	—	A	A	—	A	
Aluminum chloride	X	F	X	A	—	F	X	X	F	
Aluminum fluoride	—	—	X	—	—	—	C	C	C	
Aluminum sulphate	A	F	C	F	C	X	F	F	F	Ag
Alums	A	F	C	F	C	X	F	F	F	Ag
Ammonia gas, cold	A	C	A	A	—	A	A	A	—	
hot	X	X	—	C	—	C	C	—	—	
Ammonium chloride	A	X	X	F	F	C	F	F	—	
Ammonium hydroxide	A	X	F	C	—	A	A	A	A	
Ammonium nitrate	X	X	F	C	—	A	A	A	A	
Ammonium phosphate, monobasic	A	F	X	C	—	X	A	A	—	
dibasic	A	F	F	A	—	F	A	A	—	
tribasic	A	F	F	A	A	A	A	A	—	
Ammonium sulphate	A	F	—	A	—	A	A	A	A	
Amyl acetate	—	F	F	A	—	C	A	A	A	
Amyl alcohol	—	A	—	A	—	—	—	—	—	
Aniline, aniline oil	—	X	X	A	—	A	A	A	A	
Aniline dyes	—	—	—	A	—	—	A	—	—	
Asphalt	—	A	—	A	—	A	A	—	—	
Barium chloride	—	—	X	—	A	—	F	A	—	
Barium hydroxide	X	X	X	—	A	—	A	—	—	
Barium sulphide	A	X	—	A	—	—	A	A	A	
Beer	—	A	A	A	—	A	A	A	—	
Beet sugar liquors	—	A	A	A	—	A	A	A	—	
Benzene, benzol	A	A	A	A	—	A	A	A	—	
Benzine, petroleum ether, naphtha	A	A	A	A	—	A	A	A	—	
Black sulphate liquor	—	F	—	A	—	A	A	—	—	
Blast furnace gas	X	X	—	C	—	A	C	—	A	
Borax	—	F	F	A	A	A	A	A	A	
Boric acid	A	F	A	A	A	X	A	A	A	
Bromine	X	X	—	—	—	X	X	X	X	Ta, Zr
Butane	—	—	A	A	—	A	—	A	—	
Butyl acetate	—	A	A	—	—	—	A	A	A	
Butyl alcohol, butanol	—	A	—	A	—	A	—	—	—	
Calcium bisulphite	A	X	C	X	—	X	—	A	A	
Calcium chloride	X	A	C	F	—	A	C	C	—	
Calcium hydroxide	C	—	—	A	A	A	F	F	—	
Calcium hypochlorite	X	C	X	C	—	C	C	C	C	Ta, Zr

Asbestos

Chemical	White (comp. or woven)[4]	Blue (comp. or woven)[4]	Compressed sheet	Comp., rubber bonded: White (buna-S)[5]	Comp., rubber bonded: White (neoprene)[5]	Comp., rubber bonded: Blue (butyl)[5]	Woven, rubber frictioned: Blue (neoprene)[5]	Woven, rubber frictioned: White (neoprene)[5]	Woven, rubber frictioned: Blue (butyl)[5]
Source of data[10]	J	J	U	P	P	P	P	P	P
Acetic acid, crude	C	A	C	A	A	A	A	A	A
pure	C	A	C	A	A	A	A	A	A
vapors	C	A	C	A	A	A	A	A	A
150 p.s.i., 400 deg. F.	C	A	F	—	—	—	—	—	—
Acetic anhydride	C	A	—	A	A	A	A	A	A
Acetone	A	—	A	X	X	X	X	X	X
Acetylene	A	—	A	—	—	—	—	—	—
Air	A	—	A	A	A	A	A	A	A
Aluminum chloride	A	—	A	A	A	A	A	A	A
Aluminum fluoride	A	—	—	—	—	—	—	—	—
Aluminum sulphate	A	—	—	A	A	A	A	A	A
Alums	A	—	A	A	A	A	C	C	C
Ammonia gas, cold	A	—	A	A	A	A	A	A	A
hot	A	—	A	—	—	—	—	—	—
Ammonium chloride	C	A	A	A	A	A	A	A	A
Ammonium hydroxide	A	—	A	A	A	A	A	A	A
Ammonium nitrate	C	A	—	F	F	F	F	F	F
Ammonium phosphate, monobasic	C	A	—	A	A	A	A	A	A
dibasic	A	—	—	A	A	A	A	A	A
tribasic	A	—	—	A	A	A	A	A	A
Ammonium sulphate	C	A	A	A	A	A	A	A	A
Amyl acetate	A	—	A	C	C	C	C	C	C
Amyl alcohol	A	—	A	C	C	C	C	C	C
Aniline, aniline oil	A	—	A	—	—	—	—	—	—
Aniline dyes	A	—	A	—	—	—	—	—	—
Asphalt	A	—	F	—	—	—	—	—	—
Barium chloride	C	A	A	A	A	A	A	A	A
Barium hydroxide	A	—	A	A	A	A	A	A	A
Barium sulphide	A	—	—	—	—	—	—	—	—
Beer	A	—	A	A	A	A	X	X	X
Beet sugar liquors	A	—	A	A	A	A	A	A	A
Benzene, benzol	A	—	C	X	X	X	X	X	X
Benzine, petroleum ether, naphtha	A	—	C	X	X	X	X	X	X
Black sulphate liquor	A	—	A	—	—	—	—	—	—
Blast furnace gas	A	—	C	—	—	—	—	—	—
Borax	A	—	A	A	A	A	A	A	A
Boric acid	A	—	—	A	A	A	A	A	A
Bromine	X	C	X	X	X	X	X	X	X
Butane	A	—	A	—	—	—	—	—	—
Butyl acetate	A	—	A	C	C	C	X	X	X
Butyl alcohol, butanol	A	—	A	X	C	X	C	C	X
Calcium bisulphite	C	A	C	A	A	A	A	A	A
Calcium chloride	C	A	A	A	A	A	A	A	A
Calcium hydroxide	A	—	A	A	A	A	A	A	A
Calcium hypochlorite	C	A	A	A	A	A	A	A	A

Rubber

Chemical	GR-S	GR-S[3]	GR-S	Neoprene	Neoprene[3]	Neoprene	Buna-N	Buna-N[3]	Buna-N	Butyl	Butyl	Thiokol	Natural	Silicone[6]
Source of data[10]	A	P	U	A	P	U	A	P	U	S	U	U	U	D
Acetic acid, crude	C	A	C	C	A	F	C	A	F	A	F	F	C	—
pure	C	A	C	C	A	F	C	A	F	A	F	F	C	A
vapors	A	A	C	A	A	F	A	A	F	A	F	F	C	—
150 p.s.i., 400 deg. F.	X	—	X	X	—	F	X	—	F	—	X	X	X	—
Acetic anhydride	C	A	—	A	A	—	C	A	—	A	—	—	—	—
Acetone	A	X	A	A	X	C	X	X	X	A	A	C	F	F
Acetylene	A	—	A	A	—	C	A	—	A	—	A	C	A	—
Air	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum chloride	A	A	A	A	A	A	A	A	A	A	A	—	A	—
Aluminum fluoride	A	—	—	A	—	—	A	—	—	A	—	—	—	—
Aluminum sulphate	A	A	A	A	A	A	A	A	A	A	A	—	A	—
Alums	A	C	A	A	C	A	A	C	A	A	A	—	A	—
Ammonia gas, cold	A	F	A	A	F	A	A	F	A	—	A	A	A	—
hot	C	—	C	C	—	A	C	—	C	—	C	X	C	—
Ammonium chloride	A	A	—	A	A	A	A	A	—	A	A	C	A	—
Ammonium hydroxide	F	F	C	F	F	C	F	F	C	A	A	X	C	A
Ammonium nitrate	A	C	A	A	C	A	A	C	A	A	A	—	A	—
Ammonium phosphate, monobasic	A	A	A	A	A	A	A	A	A	A	A	—	A	—
dibasic	A	A	A	A	A	A	A	A	A	A	A	—	A	—
tribasic	A	A	A	A	A	A	A	A	A	A	A	—	A	—
Ammonium sulphate	A	A	A	A	A	A	A	A	A	A	A	—	A	A
Amyl acetate	X	X	X	X	X	X	X	X	X	—	—	C	F	—
Amyl alcohol	A	X	A	A	X	A	A	X	A	A	A	A	A	—
Aniline, aniline oil	A	—	X	X	—	F	F	—	X	A	A	A	X	—
Aniline dyes	—	—	F	—	—	F	—	—	F	—	A	C	F	—
Asphalt	X	—	X	A	—	F	A	—	F	X	X	A	X	A
Barium chloride	A	A	A	A	A	A	A	A	A	A	A	—	A	A
Barium hydroxide	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Barium sulphide	A	—	A	A	—	A	A	—	A	A	A	A	A	—
Beer	A	A	A	A	A	A	A	—	X	A	A	X	A	—
Beet sugar liquors	A	A	A	A	A	A	A	A	A	—	A	X	A	—
Benzene, benzol	X	X	X	X	X	X	X	X	X	X	X	C	X	X
Benzine, petroleum ether, naphtha	X	X	X	F	X	X	A	X	X	X	X	C	X	X
Black sulphate liquor	A	—	A	A	—	A	A	—	A	—	A	X	A	—
Blast furnace gas	A	—	C	A	—	C	A	—	C	—	C	X	C	—
Borax	A	A	A	A	A	C	A	A	F	A	A	X	A	A
Boric acid	C	A	A	C	A	A	C	A	A	A	A	X	A	A
Bromine	X	X	X	X	X	X	X	X	X	X	X	F	X	—
Butane	X	—	X	A	—	F	C	—	C	X	—	C	X	—
Butyl acetate	X	X	X	X	X	X	X	X	X	F	F	C	F	—
Butyl alcohol, butanol	A	X	A	A	C	A	A	X	A	A	A	C	A	—
Calcium bisulphite	A	A	C	A	A	—	A	A	—	A	C	—	C	—
Calcium chloride	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Calcium hydroxide	A	A	A	C	A	A	C	A	A	A	A	C	A	A
Calcium hypochlorite	F	A	C	F	A	C	F	A	C	—	A	—	C	A

Miscellaneous

Chemical	Glass fabric and silicone elastomer[7]	Glass fabric and synthetic rubber[7]	Cork composition	Plant-fiber sheet	Plant-fiber sheet	Teflon[8]	Teflon[8]
Source of data[10]	C	C	A	A	U	E	P
Acetic acid, crude	A	A	C	X	F	A	A
pure	A	A	C	X	F	A	A
vapors	A	A	C	X	F	A	A
150 p.s.i., 400 deg. F.	A	X	X	X	X	A	—
Acetic anhydride	C	C	X	X	—	A	A
Acetone	A	A	A	A	C	A	A
Acetylene	X	X	A	A	C	A	—
Air	A	A	A	A	A	A	A
Aluminum chloride	F	A	F	C	A	A	A
Aluminum fluoride	F	A	F	C	—	A	—
Aluminum sulphate	A	A	F	F	—	A	A
Alums	A	A	F	F	—	A	A
Ammonia gas, cold	A	A	X	X	A	A	A
hot	A	A	X	X	C	A	A
Ammonium chloride	F	A	F	F	X	A	A
Ammonium hydroxide	A	A	X	X	F	A	A
Ammonium nitrate	—	A	F	F	—	A	A
Ammonium phosphate, monobasic	—	A	F	F	—	A	A
dibasic	—	A	F	F	—	A	A
tribasic	—	A	F	F	—	A	A
Ammonium sulphate	—	A	F	F	—	A	A
Amyl acetate	X	C	A	A	C	A	A
Amyl alcohol	X	A	A	F	A	A	A
Aniline, aniline oil	X	C	X	A	—	A	A
Aniline dyes	X	C	C	C	—	A	A
Asphalt	C	C	A	A	F	A	A
Barium chloride	—	A	F	F	—	A	A
Barium hydroxide	A	A	F	F	F	A	A
Barium sulphide	—	A	F	F	—	A	A
Beer	A	A	A	A	A	A	A
Beet sugar liquors	A	A	A	A	A	A	A
Benzene, benzol	X	X	A	A	A	A	A
Benzine, petroleum ether, naphtha	X	C	A	A	A	A	A
Black sulphate liquor	—	—	A	A	A	A	A
Blast furnace gas	F	C	C	C	X	A	—
Borax	A	A	A	A	—	A	A
Boric acid	A	A	A	A	—	A	A
Bromine	X	X	X	X	X	A	A
Butane	X	C	A	A	X	A	—
Butyl acetate	X	A	A	A	C	A	A
Butyl alcohol, butanol	F	A	A	F	X	A	A
Calcium bisulphite	F	A	F	F	—	A	A
Calcium chloride	F	A	F	F	A	A	A
Calcium hydroxide	F	A	F	C	F	A	A
Calcium hypochlorite	F	F	X	X	F	A	A

Caliche liquors	—	—	—	A	—	A	A	—	—		C	A	—	—	—	—	—	—	—	—	—	A	—	—	A	—	—	A	—	A	X	A	—	—	A	—	—	—	A	—
Cane sugar liquors	A	A	A	A	—	A	A	A	—		A	—	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	—	A	X	A	—	A	A	F	A	F	A	A
Carbolic acid, phenol	A	X	A	A	—	C	A	A	—		A	—	—	C	C	C	C	C	C	C	C	X	C	C	C	X	C	X	—	X	—	X	—	F	C	A	A	—	A	A
Carbon dioxide, dry	A	A	A	A	—	A	A	A	—		A	—	A	C	C	C	—	—	—	A	—	A	A	—	A	A	—	A	A	A	A	A	A	A	A	X	A	X	A	A
wet	X	F	F	A	—	F	A	A	—		A	—	A	C	C	C	—	—	—	A	—	A	A	—	A	A	—	A	A	A	A	A	A	A	A	X	A	X	A	A
Carbon bisulphide	—	X	A	A	—	A	A	A	—		A	—	A	—	—	—	—	—	—	X	—	X	X	—	X	X	—	X	X	X	C	X	—	X	X	A	A	X	A	—
Carbon monoxide, hot	—	X	—	—	—	A	A	A	A		A	—	A	—	—	—	—	—	—	A	—	C	A	—	C	A	—	C	A	C	X	C	—	A	C	X	A	C	A	—
Carbon tetrachloride	F	C	C	A	—	C	C	C	C	Ag	A	—	F	C	C	C	X	X	X	X	X	X	X	X	X	A	X	X	X	X	C	X	X	X	X	A	A	C	A	A
Castor oil	—	—	A	A	—	A	A	—	—		A	—	A	C	C	C	X	X	X	A	X	A	A	X	A	A	X	A	A	A	X	A	—	C	C	A	A	A	A	A
China wood oil, tung oil	—	—	A	A	—	A	A	—	—		A	—	A	C	C	C	X	X	X	X	X	X	A	X	F	A	X	A	—	—	C	X	—	X	C	A	A	C	A	A
Chlorine, dry	A	A	A	A	—	A	A	A	—		A	—	F	X	X	C	C	X	C	X	X	F	X	C	F	F	X	F	F	F	C	A	—	X	X	X	X	X	A	A
wet	F	X	X	X	—	X	X	C	—	Ag	X	A	F	X	X	C	C	X	C	X	X	F	X	C	F	F	X	F	F	F	X	F	—	X	X	X	X	X	A	A
Chlorinated solvents, dry	A	A	A	A	—	A	A	—	—		A	—	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	C	X	X	X	X	X	X	X	A	A	X	A	A
wet	F	X	X	A	—	X	C	—	—		A	—	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	C	X	X	C	X	X	X	X	A	X	X	A	A
Chloroacetic acid	X	X	X	—	F	X	X	X	X	Ta, Zr	X	A	—	C	C	C	X	X	X	F	X	—	F	X	—	F	X	—	—	—	—	—	—	X	C	X	X	—	A	A
Chlorosulphonic acid	F	—	—	F	—	—	F	—	—		X	A	C	C	C	C	X	X	X	C	X	X	C	X	X	C	X	X	—	X	X	X	—	X	F	X	X	X	A	A
Chromic acid	A	X	X	F	—	—	—	A	—		X	A	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	C	C	X	X	—	X	F	F	X	C	A	A
Citric acid	A	A	A	A	—	X	A	A	—		C	A	C	A	A	A	A	A	A	A	A	F	A	A	A	A	A	F	A	F	X	A	—	A	A	A	A	F	A	A
Coke oven gas	—	A	—	A	—	A	—	A	—		A	—	A	—	—	—	—	—	—	C	—	C	C	—	C	C	—	C	—	C	X	C	—	A	C	X	A	X	A	—
Copper chloride	A	C	X	F	—	F	X	X	—		C	A	A	A	A	A	A	A	A	A	A	A	A	A	F	A	A	A	A	A	X	A	A	A	A	A	F	—	A	A
Copper sulphate	A	C	X	A	—	X	A	A	—		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	F	C	A	A	A	A	A	F	A	A	A
Corn oil	A	—	A	A	—	A	A	A	—		A	—	A	C	C	C	X	X	X	X	X	X	F	X	F	A	X	A	A	A	C	X	—	C	C	A	A	C	A	A
Cotton seed oil	A	C	A	A	—	A	A	A	—		A	—	A	C	C	C	X	X	X	X	X	X	F	X	F	A	X	A	A	A	C	X	—	C	C	A	A	X	A	A
Creosote, coal tar	—	A	A	A	—	A	A	A	—		A	—	A	—	—	—	—	—	—	X	—	X	F	—	F	A	—	A	X	X	C	X	—	C	C	A	A	X	A	A
wood	—	A	A	A	—	A	A	A	—		A	—	C	C	C	C	X	X	X	X	X	X	A	X	F	A	X	A	X	X	C	X	—	C	C	A	A	X	A	A
Cresols, cresylic acid	—	A	A	F	—	F	—	A	—		A	—	—	C	C	C	X	X	X	X	X	X	X	X	X	C	X	F	X	X	—	X	—	C	C	A	A	—	A	A
Dowtherm, A	—	X	A	—	—	A	—	—	—		A	—	C	—	—	—	X	X	X	X	X	X	X	X	X	X	X	X	—	X	X	X	—	—	—	C	C	X	A	—
E	—	A	X	—	—	A	—	—	—		A	—	C	—	—	—	X	X	X	X	X	X	X	X	X	X	X	X	—	X	X	X	—	—	—	C	C	X	A	—
Ethers	A	A	A	A	—	A	—	—	—		A	—	A	C	C	C	X	X	X	X	X	C	X	X	C	C	X	C	A	C	X	C	X	C	—	A	A	X	A	A
Ethyl acetate	—	A	F	A	—	A	A	A	—		A	—	A	C	C	C	X	X	X	X	X	F	X	X	X	X	X	X	A	F	F	F	—	F	F	A	A	A	A	A
Etyhl cellulose	—	—	—	A	A	—	—	—	—		A	—	F	—	—	—	—	—	—	A	—	F	A	—	F	A	—	F	—	F	C	F	—	F	F	A	A	X	A	A
Ethyl chloride	—	A	—	A	A	A	A	A	—		A	—	A	—	—	—	—	—	—	X	—	A	X	—	A	X	—	A	A	A	C	A	X	F	F	A	A	C	A	A
Ethylene glycol	A	A	A	A	—	A	A	A	A		A	—	A	—	—	—	—	—	—	A	—	A	A	—	A	A	—	A	A	A	C	A	—	A	A	A	A	A	A	A
Ferric chloride	X	X	X	X	X	X	X	X	X	Ta, Zr	C	A	—	C	C	C	C	C	C	A	C	A	A	C	A	A	C	A	A	A	—	A	—	F	A	A	F	—	A	A
Ferric sulphate	A	X	X	X	X	X	F	A	—		C	A	—	A	A	A	C	C	C	A	A	A	A	A	A	A	A	A	A	A	—	A	—	F	A	A	F	—	A	A
Formaldehyde	X	F	F	A	—	F	A	A	—	Ag	A	—	C	A	A	A	C	C	C	A	A	A	A	A	C	A	A	A	A	A	A	A	—	C	A	A	A	F	A	A
Formic acid	X	F	X	C	C	X	F	F	—	Ag	X	A	—	A	A	A	C	C	C	A	A	A	A	A	X	F	A	X	—	A	—	A	A	X	A	F	F	—	A	A
Freon	A	A	A	A	—	C	C	C	—		A	—	C	—	—	—	—	—	—	C	—	X	A	—	F	A	—	F	—	F	C	X	—	X	X	A	A	C	A	—
Fuel oil	A	A	—	A	—	A	A	—	—		A	—	A	—	—	—	—	—	—	X	—	X	F	—	F	A	—	A	X	X	C	X	X	A	A	A	A	X	A	A
Fuel oil, acid	A	C	—	A	—	C	C	—	—		A	—	—	—	—	—	—	—	—	X	—	—	F	—	—	A	—	—	X	—	—	—	—	A	A	A	A	—	A	A
Furfural	—	A	A	A	—	A	A	A	—		A	—	C	—	—	—	—	—	—	A	—	X	A	—	X	X	—	X	—	—	C	X	—	C	A	A	A	X	A	A
Gasolene, sour	A	C	C	A	—	C	C	A	—		A	—	—	—	—	—	—	—	—	X	—	X	F	—	A	A	—	A	X	X	C	X	X	X	A	A	A	—	A	A
refined	A	A	A	A	—	A	A	A	—		A	—	C	—	—	—	—	—	—	X	—	X	F	—	A	A	—	A	X	X	C	X	X	X	A	A	A	X	A	A
Gelatin	—	—	A	A	—	—	A	A	—		A	—	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	X	A	—	A	A	A	A	A	A	A
Glucose	—	A	A	A	—	A	A	A	—		A	—	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	X	A	—	A	A	A	A	A	A	A
Glue	—	—	A	A	—	A	A	A	—		A	—	A	A	A	A	A	A	A	A	A	F	A	A	A	A	A	A	A	F	X	F	—	A	A	A	A	C	A	A
Glycerin, glycerol	A	F	A	A	—	A	A	A	—		A	—	A	C	C	C	C	C	C	A	X	A	A	X	A	A	X	A	A	A	C	A	—	A	A	A	A	A	A	A
Green sulphate liquor	—	—	—	A	—	A	—	—	—		A	—	A	—	—	—	—	—	—	A	—	A	A	—	A	A	—	A	—	A	X	A	—	—	—	F	F	X	A	A
Hydrobromic acid	C	C	X	C	C	X	X	X	—		C	A	—	—	—	—	—	—	—	C	—	X	C	—	—	C	—	—	A	—	—	A	—	X	F	X	X	—	A	—
Hydrochloric acid, <150 deg. F.	F	X	X	C	C	X	X	X	—	Ag	C	A	F	A	A	A	A	A	A	F	A	F	F	A	F	F	A	A	C	A	X	A	A	X	F	X	X	—	A	A
>150 deg. F.	X	X	X	C	C	X	X	X	—	H-B,Ta,Zr	C	A	X	F	F	F	C	C	C	X	C	X	X	C	F	X	C	X	C	—	X	F	—	X	X	X	X	—	A	A
Hydrocyanic acid	—	—	—	A	—	C	A	A	—		A	—	—	—	—	—	—	—	—	F	—	—	F	—	—	F	—	—	—	—	—	—	—	X	F	X	X	—	A	—
Hydrofluoric acid, cold, <65%	F	C	X	F	X	X	X	X	X	Cu-Ni	X	A	X	—	—	—	—	—	—	C	—	F	A	—	A	C	—	—	C	F	C	F	—	X	F	X	X	X	A	—
>65%	C	F	X	A	—	F	X	X	X	Ag	X	A	X	—	—	—	—	—	—	X	—	X	X	—	X	X	—	X	C	C	X	X	—	—	—	X	X	X	A	—
hot, <65%	X	X	X	C	X	X	X	X	X		X	A	X	—	—	—	—	—	—	X	—	C	X	—	A	X	—	—	C	C	X	C	—	—	—	X	X	X	A	—
>65%	X	F	X	A	—	C	X	X	X	Ag	X	A	X	—	—	—	—	—	—	X	—	C	X	—	C	X	—	—	C	C	X	C	—	—	—	X	X	X	A	—
Hydrofluosilicic acid	A	—	—	C	—	X	X	X	X		X	A	A	—	—	—	—	—	—	F	—	A	F	—	F	F	—	A	—	A	C	A	—	X	—	X	X	X	A	—
Hydrogen gas, cold	A	A	A	A	—	A	A	A	—		A	—	A	—	—	—	—	—	—	A	—	F	A	—	A	A	—	A	A	A	C	F	A	A	A	A	A	C	A	—
hot	X	X	C	A	—	A	A	A	A		A	—	A	—	—	—	—	—	—	A	—	F	A	—	A	A	—	A	A	A	C	F	—	A	A	X	A	C	A	—
Hydrogen peroxide	F	X	A	F	F	X	A	A	—		A	—	—	C	C	C	X	X	X	A	X	F	A	X	A	A	X	—	—	F	C	F	A	A	A	X	X	—	A	—
Hydrogen sulphide, dry, cold	—	X	A	A	A	A	A	A	A		A	—	—	C	C	C	X	X	X	A	C	C	A	C	F	A	C	C	A	A	A	C	—	C	A	X	A	—	A	A
hot	—	X	A	X	X	X	C	C	A	502	A	—	—	C	C	C	X	X	X	C	C	C	C	C	F	C	C	C	A	A	A	C	—	C	A	X	A	—	A	A
wet, cold	—	X	A	A	A	C	A	A	A		A	—	—	C	C	C	X	X	X	F	C	C	F	C	F	F	C	C	A	A	A	C	—	C	A	X	A	—	A	A
hot	—	X	A	X	X	X	C	C	A		A	—	—	C	C	C	X	X	X	C	X	C	C	X	F	C	X	C	A	A	A	C	—	C	A	X	A	—	A	A
Kerosene	A	A	—	A	—	A	A	A	—		A	—	A	C	C	C	X	X	X	X	X	C	F	X	F	A	X	A	X	X	C	C	X	F	A	A	A	C	A	A
Lacquers	—	C	A	A	—	C	A	A	—		A	—	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	C	X	C	X	—	X	A	A	A	X	A	A
Lacquer solvents	—	C	A	A	—	C	A	A	—		A	—	C	C	C	C	X	X	X	X	X	X	X	X	X	X	X	X	C	X	C	X	—	X	A	A	A	X	A	A
Lactic acid, cold	—	C	C	A	A	X	C	F	F	Sn	A	—	A	A	A	A	A	A	A	A	A	C	A	A	C	A	A	C	A	C	X	C	—	A	A	A	F	C	A	A
hot	—	C	X	C	C	X	C	C	C	Ag (Fair)	C	A	A	A	A	A	A	A	A	C	A	C	C	A	C	C	A	C	A	C	X	C	—	A	A	X	X	C	A	A
Linseed oil	A	A	A	A	—	A	A	A	—		A	—	A	C	C	C	C	C	C	X	X	C	F	X	F	A	X	A	A	A	C	C	—	X	C	A	A	C	A	A

Chemical Resistance of Gasket Materials (Continued)

Resistance Ratings[1]
A = Good
F = Fair
C = Depends on conditions
X = Unsuitable

CAUTION: Do not use table without reading footnotes and text.

Metals

	Lead	Copper	Aluminum	Monel	Nickel	Iron and Steel	Stainless 304	Stainless 316	Stainless 347	Others with good resistance[3]
Source of data[10]	G	G	G	G	G	G	G	G	G	G
Lubricating oils, sour	A	C	C	A	—	C	C	—	A	
refined	A	A	A	A	—	A	A	—	A	
Magnesium chloride	X	F	X	F	F	F	F	F	—	Ag
Magnesium hydroxide	—	X	X	A	A	A	A	A	—	
Magnesium sulphate	—	A	C	A	—	A	A	A	—	
Mercuric chloride	—	X	X	X	X	C	X	X	X	
Mercury	—	X	X	A	—	A	A	A	—	
Methyl alcohol, methanol	A	A	A	A	—	A	A	A	—	
Methyl chloride	A	A	—	A	—	A	—	—	—	
Milk	—	—	A	A	A	A	—	A	—	
Mineral oils	A	A	A	A	—	A	A	A	—	
Natural gas	A	C	A	A	—	A	A	A	—	
Nickel chloride	—	X	X	C	—	—	F	F	—	
Nickel sulphate	—	X	X	C	—	—	A	A	—	
Nitric acid, crude	X	X	C	X	X	X	C	C	—	Pt
diluted	X	X	X	X	X	X	A	A	—	Pt
concentrated	X	X	A	X	X	X	F	F	—	Pt
Nitrobenzene	—	F	—	—	—	A	—	A	—	
Oleic acid	X	X	A	A	A	—	A	A	—	
Oleum spirits	—	A	—	A	—	A	—	—	—	
Oxalic acid	X	C	A	A	—	C	C	C	—	Ag
Oxygen, cold	A	A	A	A	—	A	A	A	—	
<500 deg. F.	X	A	A	A	—	A	A	A	—	
500–1,000 deg. F.	X	X	C	A	—	A	A	A	A	
>1,000 deg. F.	X	X	X	X	A	X	X	X	A	Inc., 502
Ozone	—	—	—	—	—	—	—	—	—	
Palmitic acid	A	A	A	A	—	A	A	A	—	
Petroleum oils, crude, <500 deg. F.	C	C	A	C	C	A	A	A	—	410
>500 deg. F.	X	X	A	X	X	A	A	A	—	410, 502
>1,000 deg. F.	X	X	X	X	X	X	C	C	A	410, 502
Phosphoric acid, crude	C	X	X	X	X	C	C	C	—	
pure, <45%	A	F	C	F	C	X	A	A	—	
>45%, cold	A	F	X	F	C	X	A	A	—	
hot	X	C	X	C	—	X	X	C	—	
Picric acid, molten	X	X	F	X	X	A	A	A	—	
water solution	X	X	X	C	X	C	A	A	—	
Potassium chloride	A	A	C	A	A	A	A	A	—	
Potassium cyanide	X	X	X	A	—	A	A	A	—	
Potassium hydroxide	X	X	X	A	A	C	F	F	—	
Potassium sulphate	A	A	A	A	A	A	F	F	—	
Producer gas	A	C	A	A	—	A	—	—	—	
Propane	A	—	—	A	—	A	A	A	—	
Sewage	A	C	F	A	—	F	F	F	—	
Soap solutions	A	C	—	A	—	A	A	—	—	
Soda ash, sodium carbonate	A	C	X	A	—	A	A	A	—	
Sodium bicarbonate, baking soda	A	C	X	A	A	C	A	A	—	

Asbestos

	White (comp. or woven)[4]	Blue (comp. or woven)[4]	Compressed sheet	Comp., rubber bonded: White (buna-S)[5]	Comp., rubber bonded: White (neoprene)[5]	Comp., rubber bonded: Blue (butyl)[5]	Woven, rubber frictioned: Blue (neoprene)[5]	Woven, rubber frictioned: White (neoprene)[5]	Woven, rubber frictioned: Blue (butyl)[5]
Source of data[10]	J	J	U	P	P	P	P	P	P
Lubricating oils, sour	A	—	A	C	C	C	C	C	C
refined	A	—	A	C	C	C	C	C	C
Magnesium chloride	C	A	A	A	A	A	C	C	C
Magnesium hydroxide	A	—	A	A	A	A	C	C	C
Magnesium sulphate	C	A	—	A	A	A	C	C	C
Mercuric chloride	C	A	—	A	A	A	C	C	C
Mercury	A	—	C	—	—	—	—	—	—
Methyl alcohol, methanol	A	—	A	F	F	F	C	C	C
Methyl chloride	A	—	C	C	C	C	—	—	—
Milk	A	—	—	A	A	A	X	X	X
Mineral oils	A	—	A	C	C	C	X	X	X
Natural gas	A	—	A	—	—	—	—	—	—
Nickel chloride	C	A	—	A	A	A	A	A	A
Nickel sulphate	C	A	—	A	A	A	A	A	A
Nitric acid, crude	X	A	C	X	X	X	X	X	X
diluted	X	A	C	C	C	C	X	X	X
concentrated	X	A	X	X	X	X	X	X	X
Nitrobenzene	C	A	—	—	—	—	—	—	—
Oleic acid	A	—	A	—	—	—	—	—	—
Oleum spirits	X	A	—	C	C	C	X	X	X
Oxalic acid	X	A	A	A	A	A	A	A	A
Oxygen, cold	A	—	A	—	—	—	—	—	—
<500 deg. F.	A	—	C	—	—	—	—	—	—
500–1,000 deg. F.	A	—	—	—	—	—	—	—	—
>1,000 deg. F.	X	—	X	—	—	—	—	—	—
Ozone	—	—	—	—	—	—	—	—	—
Palmitic acid	A	—	A	—	—	—	—	—	—
Petroleum oils, crude, <500 deg. F.	A	—	A	C	C	C	X	X	X
>500 deg. F.	A	—	C	—	—	—	X	X	X
>1,000 deg. F.	C	—	X	—	—	—	X	X	X
Phosphoric acid, crude	X	A	A	A	A	A	C	C	C
pure, <45%	X	A	A	A	A	A	C	C	C
>45%, cold	X	A	A	A	A	A	C	C	C
hot	X	A	—	F	F	F	C	C	C
Picric acid, molten	C	A	A	—	—	—	—	—	—
water solution	X	A	A	C	C	C	C	C	C
Potassium chloride	A	—	—	A	A	A	A	A	A
Potassium cyanide	A	—	—	—	—	—	—	—	—
Potassium hydroxide	A	—	—	C	C	C	C	C	C
Potassium sulphate	A	—	—	A	A	A	A	A	A
Producer gas	A	—	A	—	—	—	—	—	—
Propane	A	—	A	—	—	—	—	—	—
Sewage	A	—	A	—	—	—	—	—	—
Soap solutions	A	—	C	A	A	A	A	A	A
Soda ash, sodium carbonate	A	—	A	A	A	A	A	A	A
Sodium bicarbonate, baking soda	A	—	A	A	A	A	A	A	A

Rubber

	GR-S	GR-S[5]	GR-S	Neoprene	Neoprene[5]	Neoprene	Buna-N	Buna-N[5]	Buna-N	Butyl	Butyl	Thiokol	Natural	Silicone[6]
Source of data[10]	A	P	U	A	P	U	A	P	U	S	U	U	U	D
Lubricating oils, sour	X	X	F	F	X	A	A	X	A	X	X	C	F	—
refined	X	X	F	F	X	A	A	X	A	X	X	C	F	A
Magnesium chloride	A	A	A	A	A	A	A	A	A	A	A	C	A	—
Magnesium hydroxide	F	A	A	F	A	A	F	A	A	A	A	C	A	A
Magnesium sulphate	A	A	A	A	A	A	A	A	A	A	A	—	A	A
Mercuric chloride	A	A	—	A	A	—	A	A	—	A	—	—	—	—
Mercury	A	—	—	A	—	—	A	—	—	A	—	—	—	—
Methyl alcohol, methanol	A	F	A	A	F	A	A	F	A	A	A	C	A	—
Methyl chloride	X	X	C	X	X	C	X	X	C	A	C	X	C	—
Milk	A	A	A	A	A	A	A	A	A	A	A	X	A	A
Mineral oils	X	X	C	F	X	F	A	X	A	X	X	C	C	A
Natural gas	F	—	F	A	—	A	A	—	A	X	X	C	F	—
Nickel chloride	A	A	A	A	A	A	A	A	A	A	A	—	A	—
Nickel sulphate	A	A	A	A	A	A	A	A	A	A	A	—	A	—
Nitric acid, crude	X	X	X	X	X	X	X	X	X	C	C	—	X	—
diluted	X	X	X	X	X	X	X	X	X	C	A	—	X	A
concentrated	X	X	X	X	X	X	X	X	X	C	C	—	X	A
Nitrobenzene	X	—	X	X	—	X	F	—	C	X	X	—	X	—
Oleic acid	F	—	F	C	—	A	F	—	A	A	—	—	F	—
Oleum spirits	F	X	—	A	X	—	A	X	—	—	—	—	—	—
Oxalic acid	F	A	F	F	A	—	F	A	—	A	—	—	F	—
Oxygen, cold	C	—	C	A	—	A	C	—	C	A	—	C	C	A
<500 deg. F.	X	—	C	X	—	C	X	—	C	C	—	—	C	A
500–1,000 deg. F.	X	—	—	X	—	—	X	—	—	—	—	—	X	X
>1,000 deg. F.	X	—	X	X	—	X	X	—	X	—	X	X	X	—
Ozone	—	—	—	—	—	—	—	—	—	—	—	—	—	A
Palmitic acid	A	—	F	A	—	A	A	—	A	A	F	C	F	—
Petroleum oils, crude, <500 deg. F.	X	X	C	F	X	A	A	X	A	X	X	C	C	—
>500 deg. F.	X	X	C	X	X	X	X	X	X	X	X	X	C	—
>1,000 deg. F.	X	X	X	X	X	X	X	X	X	X	X	X	X	—
Phosphoric acid, crude	F	A	C	F	A	C	F	A	C	A	C	—	C	—
pure, <45%	F	A	C	F	A	C	F	A	C	A	C	—	C	—
>45%, cold	F	A	C	F	A	C	F	A	C	A	C	—	C	—
hot	X	C	C	X	C	C	X	C	C	A	C	—	C	—
Picric acid, molten	—	—	C	—	—	C	—	—	C	—	C	X	C	—
water solution	F	C	C	F	C	A	F	C	A	—	A	X	A	—
Potassium chloride	A	A	A	A	A	A	A	A	A	A	A	—	A	A
Potassium cyanide	A	—	A	A	—	A	A	—	A	A	A	—	A	—
Potassium hydroxide	C	C	A	C	C	A	C	C	A	A	A	—	A	A
Potassium sulphate	A	A	A	A	A	A	A	A	A	A	A	—	A	A
Producer gas	X	—	—	F	—	—	A	—	—	—	—	C	—	—
Propane	—	—	—	A	—	F	A	—	A	X	—	A	—	—
Sewage	A	—	C	A	—	F	A	—	A	—	X	C	C	A
Soap solutions	A	A	C	A	A	F	A	A	A	A	—	C	C	A
Soda ash, sodium carbonate	A	A	A	A	A	A	A	A	A	A	A	C	A	A
Sodium bicarbonate, baking soda	A	A	A	A	A	A	A	A	A	A	A	C	A	—

Miscellaneous

	Glass fabric and silicone elastomer[7]	Glass fabric and synthetic rubber[7]	Cork composition	Plant-fiber sheet	Plant-fiber sheet	Teflon[8]	Teflon[8]
Source of data[10]	C	C	A	A	U	E	P
Lubricating oils, sour	C	A	A	A	C	A	A
refined	C	A	A	A	C	A	A
Magnesium chloride	A	A	X	F	C	A	A
Magnesium hydroxide	A	A	A	F	C	A	A
Magnesium sulphate	A	A	A	A	—	A	A
Mercuric chloride	A	A	A	A	—	A	A
Mercury	A	A	A	A	—	A	—
Methyl alcohol, methanol	F	A	A	F	C	A	A
Methyl chloride	C	A	C	C	—	A	A
Milk	A	A	A	A	—	A	A
Mineral oils	A	A	A	A	C	A	A
Natural gas	C	A	A	A	—	A	—
Nickel chloride	A	A	F	F	—	A	A
Nickel sulphate	A	A	F	F	—	A	A
Nitric acid, crude	A	A	X	X	—	A	A
diluted	F	A	X	X	—	A	A
concentrated	C	X	X	X	—	A	A
Nitrobenzene	X	C	F	X	—	A	A
Oleic acid	X	X	A	A	—	A	A
Oleum spirits	X	X	A	A	—	A	A
Oxalic acid	C	A	A	F	C	A	A
Oxygen, cold	X	X	C	A	C	A	—
<500 deg. F.	X	X	X	X	X	X	—
500–1,000 deg. F.	X	X	X	X	—	X	—
>1,000 deg. F.	X	X	X	X	X	X	—
Ozone	—	—	—	—	—	—	—
Palmitic acid	X	C	A	A	C	A	—
Petroleum oils, crude, <500 deg. F.	F	A	A	C	X	A	A
>500 deg. F.	X	X	X	X	X	X	X
>1,000 deg. F.	X	X	X	X	X	X	X
Phosphoric acid, crude	X	A	X	X	—	A	A
pure, <45%	X	F	X	X	—	A	A
>45%, cold	X	X	X	X	—	A	A
hot	X	X	X	X	—	A	A
Picric acid, molten	X	X	X	X	C	A	—
water solution	X	A	X	X	A	A	A
Potassium chloride	A	A	A	F	—	A	A
Potassium cyanide	A	A	A	F	—	A	—
Potassium hydroxide	A	A	X	X	—	A	A
Potassium sulphate	A	A	A	X	—	A	A
Producer gas	A	A	C	A	—	A	—
Propane	A	A	A	A	—	A	—
Sewage	C	A	X	F	C	A	—
Soap solutions	A	A	F	F	C	A	A
Soda ash, sodium carbonate	A	A	X	X	A	A	A
Sodium bicarbonate, baking soda	A	A	A	F	A	A	A

Sodium bisulphate	A F C	A A X	C C —		C A A	A A A	A A A	A A A	A A A	A A A	A A	C A —	A	A	A F A	A A
Sodium chloride	A F X	A A A	F A —		A — A	A A A	A A A	A A A	A A A	A A A	A A	C A A	A	A	A A A	A A
Sodium cyanide	X X X	F — A	— A —		A — —	— — —	— — —	A — A	A — A	A — A	A A	— A —	A	A	A A —	A A
Sodium hydroxide	F X X	A A A	F F —		A — A	A A A	A A A	C A C	C A C	C A C	A A	C C A	A	A	X X C	A A
Sodium hypochlorite	X C X	C C X	X X —	Pt	C A A	A A A	A A A	F A C	F A C	F A C	A C	— C A	A	A	X X C	A A
Sodium metaphosphate	A C A	A A —	A — —		C A A	A A A	A A A	A A A	A A C	A A A	A A	— A —	A	A	F F A	A A
Sodium nitrate	A F A	A A A	F A —		C A C	A A A	A A A	A A C	A A C	A A C	A A	— C —	A	A	A A —	A A
Sodium perborate	— — A	A A C	A A —		A — C	— — —	— — —	A — C	A — C	A — C	A A	— C —	A	A	X X —	A A
Sodium peroxide	— — A	A A C	A A —		A — C	— — —	— — —	F — C	F — C	F — C	A A	— C —	C	A	X X —	A A
Sodium phosphate, monobasic	— C A	A A C	— A —		C A A	A A A	A A A	F A A	F A C	F A A	A A	— A —	C	A	F F A	A A
dibasic	— A A	A A C	— A —		A — A	A A A	A A A	F A A	F A C	F A A	A A	— A —	C	A	F F A	A A
tribasic	A X X	A A A	— A —		A — A	A A A	A A A	F A A	F A C	F A A	A A	— A —	C	A	F F A	A A
Sodium silicate	X C X	A A A	— A —		A — A	A A A	A A A	A A A	A A A	A A A	A A	— A A	A	A	F X —	A A
Sodium sulphate	A A C	A A A	A A A		A — A	A A A	A A A	A A A	A A A	A A A	A A	— A A	A	A	A F —	A A
Sodium sulphide	A X X	F F A	A A A		A — A	— — —	— — —	A — A	A — A	A — A	A A	— A —	A	A	X X —	A A
Sodium thiosulphate, "hypo"	A X X	C — C	A A —		A — A	A A A	A A A	A A A	A A —	A A A	A A	— A A	A	A	A F A	A A
Soybean oil	— — —	— — —	A A —		A — A	— — —	— — —	X — C	A — A	A — A	A A	— C —	X	C	A A C	A A
Stannic chloride	— X X	X X —	C C —	Ta, Zr	X A A	A A A	A A A	A A A	A A A	A A A	A F	— A —	C	A	C X C	A A
Steam, <500 deg. F.	C A A	A A A	A A A		A — A	— — —	— — —	F — A	F — C	F — A	C —	— C A	F	A	X X X	A —
500–1,000 deg. F.	X C C	C C A	A A A	502	A — C	— — —	— — —	X — X	X — X	X — X	— —	— X —	X	X	X X X	X —
>1,000 deg. F.	— X X	X X X	A A A	Inc., 502	C — X	— — —	— — —	X — X	X — X	X — X	— —	— X —	X	X	X X X	X —
Stearic Acid	A C C	A A C	A A —	Ag	A — A	C C C	X X X	A X C	A X A	A X A	A C	— C A	X[9]	F[9]	A A C	A A
Sulphur	— X A	X X A	F F —		A — A	— — —	— — —	A — F	A — A	A — F	A F	A F —	A	C	A A C	A —
Sulphur chloride	A X —	C — C	— C —		X A C	— — —	— — —	C — X	C — F	C — F	X X	X X —	X	C	X X X	A —
Sulphur dioxide, dry	A A A	A A A	A A —		A — A	C C C	— — —	C C C	C C C	C C C	A C	— C —	F	C	F X C	A A
Sulphur trioxide, dry	A A A	A — A	A — —		A — —	C C C	— — —	C C C	C C C	C C C	A C	— A —	X	C	X X —	A A
Sulphuric acid, <10%, cold	A C C	C C X	F F —	Pt	F A A	A A A	A A A	A A A	A A A	A A A	A A	— A A	A	A	X X —	A A
hot	A X C	C X X	X F —	Pt	F A A	C C C	C X C	F F A	F F A	F F A	A A	— A —	F	A	X X —	A A
10–75%, cold	A X C	C C X	X F —	Pt	X A F	X X X	X X X	C X C	C X C	C X C	C A	— C A	A	A	X X —	A A
hot	A X X	C X X	X X —	Pt	X A F	X X X	X X X	X X C	X X C	X X C	C A	— C —	F	A	X X —	A A
75–95%, cold	A X C	C C C	A A —	Pt	X A C	X X X	X X X	C X C	C X C	C X C	C A	— C X	X	F	X X X	A A
hot	A X X	C X F	X X —	Pt	X A C	X X X	X X X	X X X	X X X	X X X	C C	— X —	X	F	X X X	A A
fuming	A X C	X X C	C F —	Pt	X A X	X X X	X X X	X X X	X X X	X X X	X X	— X —	X	X	X X —	A A
Sulphurous acid	A C C	X X A	X C —	Pt	X A A	A A A	A A A	F A C	F A C	F A C	A C	— A —	F	A	X X —	A A
Tannic acid	X A X	A A —	F F —		A — —	A A A	A A A	F A C	F A C	F A C	A C	— A —	A	A	A A —	A A
Tar	— — A	— — A	A — —		A — A	— — —	— — —	C — C	A — C	A — C	X X	— C —	C	A	A A X	A —
Tartaric acid	A — A	C C X	C A —		A — —	A A A	A A A	A A C	A A C	A A C	A C	— A —	A	A	A F —	A A
Toluene	A — A	A — A	— — —		A — A	C C C	X X X	X X X	X X F	F X A	X X	A X X	X	C	A A X	A A
Trichloroethylene	F C C	A — C	C C —		A — C	C C C	X X X	X X X	X X C	X X C	X X	X X X	X	X	A A X	A A
Turpentine	A C A	A — —	A A —		A — A	C C C	X X X	X X C	C X A	A X A	X X	C C —	C	C	A A X	A A
Vinegar	— — C	A — C	F A —		A — A	A A A	A A A	A A C	A A C	A A C	A A	— C A	A	A	A F X	A A
Water, acid mine, cont'g oxidizing salts	C C C	X X X	A A —		A — A	A A A	A A A	A A A	A A C	A A A	A A	X A —	A	A	X F C	A A
no oxidizing salts	— — A	A — C	— X —		A — A	A A A	A A A	A A A	A A C	A A A	A A	X A —	A	A	X F C	A A
Water, fresh (tap, b'l'r f'd, etc.)	A A A	A — C	A A —		A — A	A A A	A A A	A A A	A A C	A A A	A A	C A A	A	A	F A A	A A
distilled, lab. grade	X X A	C A X	A A —		A — A	X X X	X X X	A X A	A X C	A X A	A A	C A A	A	A	X A A	A A
return condensate	A A A	A — A	A A —		A — A	C C C	C C C	A C A	A C C	A C A	A A	C A A	A	A	F A A	A A
Water, seawater	A C X	A — C	F F —		A — A	A A A	A A A	A A A	A A C	A A A	A A	C A A	A	A	F F A	A A
Whiskey and wines	— A —	A — X	F A —		A — A	C C C	X X X	A C A	A C A	A C A	A A	X A —	A	A	A A A	A A
Zinc chloride	A X X	A — C	X X —		X A C	A A A	A A A	A A C	A A C	A A C	A A	— C —	A	A	F X A	A A
Zinc sulphate	— X C	A — C	A A —		X A A	A A A	A A A	A A A	A A A	A A A	A A	— A —	A	A	F F A	A A

FOOTNOTES:

As explained in the text, there are at least eight factors which must be considered when choosing a gasket for corrosive service. Any table of this type is therefore of questionable value in the selection of a gasket for a critical installation, as it is obviously impossible to take into account the effects of all these variables, singly or in combination. However the table will be useful in indicating the degree of safety with which the various materials may be used in the service shown.

1. Those materials known to be suitably resistant have been rated as "A." Those whose resistance is only fair, but not so low as to be dangerous, have been given an "F" rating. An "X" denotes that the material is totally unsuitable. The "C" rating means that the use of this material is dependent upon specific service conditions and should not be selected unless carefully investigated. The blank spaces for the most part represent absence of data. However, in some instances in the data on metals, a space has been left blank because some other metal listed is entirely suitable and less costly.

2. Unless otherwise noted, the corrosion resistance of the metals has been rated on the basis of exposure to a pure reagent in the temperature range from 50 deg. F. to boiling.

3. Abbreviations in this column stand for: Cupro-nickel, Hastelloy-B, Inconel, platinum, silver, stainless steels Types 410 and 502, tantalum, and zirconium.

4. The generally accepted temperature limit for a good grade compressed asbestos sheet, also called asbestos composition sheet, is 750 deg. F. However, some grades are successfully used at considerably higher temperatures. This type of sheet is used for smooth flanges. For rough flanges, gaskets cut from asbestos-metallic sheet or formed by folding asbestos-metallic cloth are preferred. The latter, and gaskets cut from felted asbestos sheet, are indicated for flanges when bolt pressures are necessarily limited due to the type of flange material.

5. Data from the Pfaudler Co. are given from the special point of view of the gasket material's suitability for use with glass-lined steel equipment.

6. Data in this column apply specifically to Silastic 181, a special silicone rubber for use in gasketing produced by Dow-Corning Corp.

7. Fiberglas fabric filled with Silastic silicone rubber (polysiloxane elastomer) has a usable compressibility of about 20 percent and shows the chemical resistance cited here over the temperature range from —85 deg. F. to 392 deg. F. For Fiberglas fabric filled with chemically resistant synthetic rubber the temperature range is approximately —40 deg. F. to 257 deg. F. Both the silicone rubber and the ordinary synthetic rubber are available as gasket materials in which the reinforcing fabric is a metal cloth (brass, aluminum, iron, stainless steel). The chemical properties of these constructions are the same as those given here for the Fiberglas-reinforced material, with the properties of the metal in the cloth imposed upon them. The metal-cloth construction provides for increased mechanical strength and electrical conductivity.

8. Teflon is the Du Pont trade name for polymerized tetrafluoroethylene. It is completely inert in the presence of all known chemicals. It is not affected by any known solvent or combination of solvents. It is chemically stable up to 617 deg. F. but, being a plastic, it is not recommended for gasket applications above 392 deg. F. or for high pressures unless confined in a tongue-and-groove or similar joint.

9. Hot

10. Sources of data: A, Armstrong Cork Co.; C, Connecticut Hard Rubber Co.; D, Dow-Corning Corp.; E, E. I. du Pont de Nemours & Co.; G, Goetze Gasket and Packing Co.; J, Johns-Manville Corp.; P, The Pfaudler Co.; S, Stanco Distributors, Inc.; U, United States Rubber Co.

DIRECTORY OF MATERIALS

For the Construction of Chemical Equipment

This portion of *Chemical Engineering's* Twelfth Report on Materials of Construction provides a quick means of identifying materials available for the construction of chemical plant equipment. Generous cooperation on the part of the manufacturers has made it possible to include nearly 600 items. Materials are arranged alphabetically within each of seven classes of material. Numbers in the first column are used to identify materials appearing in the Chemical Resistance table which follows this Directory.

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
	METALS & ALLOYS				
1	**Acipco Stainless**	Amer. Cast Iron Pipe Co., Birmingham, Ala.	Various standard stainless steels; see Nos. 275–360	C, T (centrifugal)	
2	**Admiralty**	Generally available[1]	70 Cu; 1 Sn; 29 Zn	CR, D, E, P, S, T, R, W	C
3	**Admiralty, Antimonial**	Chase Brass & Copper Co., Waterbury, Conn.	71 Cu; 27.95 Zn; 1 Sn; 0.05 Sb	T, W	C
4	**Admiralty, Arsenical**	Amer. Brass Co., Waterbury, Conn.	70 Cu; 28.95 Zn; 1 Sn; 0.05 As	T	C
5	**Admiralty, Phosphorized**	Scoville Mfg. Co., Waterbury, Conn.	70 Cu; 29 Zn; 1 Sn; 0.03 P		C
6	**Adnic**	Scoville Mfg. Co., Waterbury, Conn.	70 Cu; 29 Ni; 1 Sn	S	C, A
7	**Advance**	Driver Harris Co., Harrison, N. J.	55 Cu; 45 Ni	B, CR, HR, P, R, S, W	H
8	**Alchrome 3**	Wilbur B. Driver Co., Newark, N. J.	Fe; 20 Cr; 3 Al	R, W	H
9	**Alchrome 6**	Wilbur B. Driver Co., Newark, N. J.	Fe; 20 Cr; 6 Al	R, W	H
10	**Alcoa Alclad 3S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Surface layer of Al alloy which is anodic to core and therefore protects it electrolytically.	CR, HR, P, S, T	C
11	**Alcoa Alloy 43**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; 5 Si	C	C
12	**Alcoa Alloy B214**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; 1.8 Si; 3.8 Mg	C	C
13	**Alcoa Alloy 356-T4**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; 7 Si	C	C
14	**Alcoa 2S**	Aluminum Co. of Amer., Pittsburgh, Pa.	99 min. Al	B, CR, HR, D, E, F, P, S, R, T, W	C
15	**Alcoa 3S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; 1.2 Mn	CR, HR, D, E, P, S, T	C
16	**Alcoa 52S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; 2.5 Mg; 0.25 Cr	D, E, P, S, T	C
17	**Alcoa 61S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; 1 Mg; 0.6 Si; 0.25 Cr; 0.25 Cu	B, CR, HR, D, E, F, P, S, R, T, W	C
18	**Allegheny Metal**	Allegheny Ludlum Steel Corp., Brackenridge, Pa.	Various standard stainless steels; see Nos. 275–360	B, C, CR, P, S, R, T, W	C, H, A
19	**Aloyco-20**	Alloy Steel Products Co., Linden, N. J.	Fe; 19–21 Cr; 28–30 Ni; 4.0–4.5 Cu; 2.5–3.0 Mo; 1.5 max. Si; 0.65–0.85 Mn; 0.07 max. C	C	C
20	**Alray D**	Alloy Metal Wire Co., Prospect Park, Pa.	Fe; 35 Cr; 15 Ni	W	H
21	**Alumel**	Hoskins Mfg. Co., Detroit, Mich.	94 Ni; 4 Al; 1 Si; 1 Mn	CR, W	H
22	**Ambraloy 901**	Amer. Brass Co. Waterbury Conn.	95 Cu; 9 Al	B, P, S, R, T, W	C
23	**Ambraloy 917**	Amer. Brass Co., Waterbury, Conn.	82 Cu; 9½ Al; 5 Ni; 2½Fe; 1 Mn	B, P, R	C
24	**Ambraloy 927**	Amer. Brass Co., Waterbury, Conn.	76 Cu; 21.95 Zn; 2 Al; 0.05 As	T	C
25	**American Stainless**	Amer. Steel Castings Co., Newark, N. J.	Various standard stainless steels; see Nos. 275–360	C	C, H
26	**American AW**	Amer. Steel Castings Co., Newark, N. J.	Fe; 23.5 Ni; 19 Cr; 0.07 max. C	C	C
27	**A Metal**	Midvale Co., Philadelphia, Pa.	Fe; 19 Cr; 35 Ni; 0.35 C; 1 Si; 0.5 Mn	C	H
28	**AMF**	Midvale Co., Philadelphia, Pa.	Fe; 46–50 Ni; 0.1–0.2 C; 1–2 Mn	C	C
29	**Ampco 8**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 7½ Al; 2–2½ Fe	B, CR HR, D, P, S, R, T, W	C, A
30	**Ampco 12**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 8.5–9.3 Al; 2.5–3.25 Fe	C	C, A
31	**Ampco 15**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 9–10 Al; 2.75–3.75 Fe	B, CR, HR, D, P, S, R, T	C, A
32	**Ampco 16**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 9.6–10.3 Al; 3–4 Fe	C	C, A
33	**Ampco 18**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 10.3–11 Al; 3.0–4.25 Fe	B, C, D, R, T	C, A
34	**Ampcoloy 40**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 9.5–10.5 Al; 0.20 max. Fe	C	C, A
35	**Ampcoloy 45**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 9.7–10.9 Al; 2.0–3.5 Fe; 4.5–5.5 Ni; 1.5 max. Mn	B, C, D, R, T	C, A

[1] "Generally available" copper alloys may be obtained from such companies as the following: American Brass Co., Waterbury, Conn.; Bridgeport Brass Co., Bridgeport, Conn.; Bristol Brass Co., Bristol, Conn.; Chase Brass & Copper Co., Waterbury, Conn.; Mueller Brass Co., Huron, Mich.; New England Brass Co., Taunton, Mass.; Phelps Dodge Copper Products Corp., New York, N. Y.; Revere Copper & Brass, Inc., New York, N. Y.; Riverside Metal Co., Riverside, N. J.; Scovill Mfg. Co., Waterbury, Conn.; Seymour Mfg. Co., Seymour, Conn.; Wolverine Tube Co., Detroit, Mich.

NOTE: Primarily for: C, corrosion; H, heat; A, abrasion. Forms available: B, bars; C, castings; CR, cold rolled; D, drawn; E, extrusions; F, forgings; HR, hot rolled; P, plates; R, rods; S, sheets; T, tubes W, wire.

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
36	**Ampcoloy 49**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 6½–9 Al; 4 max. Fe; 2 max. Mn	B, D, R, T, W	C, A
37	**Ampcoloy 62**	Ampco Metal, Inc., Milwaukee, Wis.	55–60 Cu; 0.5–1.5 Al; 0.4–2.0 Fe; 1.5 max. Mn; 1.0 max. Sn; 0.4 max. Pb; 0.5 max. Ni; bal. Zn	C	C, A
38	**Ampcoloy 66**	Ampco Metal, Inc., Milwaukee, Wis.	60–68 Cu; 3–7 Al; 2–4 Fe; 2.5–5 Mn; 0.5 max. Sn; 0.2 max. Pb; 0.5 max. Ni; bal. Zn	C	C, A
39	**Ampcoloy A3**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 9–10 Al; 1.25 max. Fe	B, C, D, R, T	C, A
40	**Ampcoloy E123**	Ampco Metal, Inc., Milwaukee, Wis.	Cu; 9.5–11 Al; 1.5 max. Fe	C	C, A
41	**Amsco Alloys**	Amer. Manganese Steel Div., Amer. Brake Shoe Co., Chicago Heights, Ill.	Now produced under tradename Thermalloy by Electro Alloys Div.		
42	**Antaciron**	Worthington Pump & Machinery Corp., Harrison, N. J.	Fe; 14.5 Si	C	CA
43	**Armco & Rustless Stainless**	Amer. Rolling Mill Co., Middletown, Ohio	Various standard stainless steels; see Nos. 275–360	B, CR, HR, D, P, S, W, strip	C, H, A
44	**Armco Aluminized Steel**	Amer. Rolling Mill Co., Middletown, Ohio	Hot-dip Al coating on mild & Cu-bearing steel	S, strip	C, H
45	**Armco Galvanized Paintgrip**	Amer. Rolling Mill Co., Middletown, Ohio	Bonderized galvanized sheets	S, strip	C
46	**Armco Galvanized Steel or Ingot Iron**	Amer. Rolling Mill Co., Middletown, Ohio	Hot-dip galvanized on mild or Cu-bearing steel or Armco Ingot Iron	S, strip	C
47	**Armco Zincgrip**	Amer. Rolling Mill Co., Middletown, Ohio	Galvanized steel	S, strip	
48	**Armco Zincgrip Paintgrip**	Amer. Rolling Mill Co., Middletown, Ohio	Bonderized galvanized steel	S, strip	
49	**Asarco Lead**	Amer. Smelting & Ref. Co., New York, N. Y.	Pb; 0.06 Cu; 0.02 Bi	C, CR, R, S, T, W	C
50	**Beraloy**	Wilbur B. Driver Co., Newark, N. J.	Cu; 1.9 Be; 0.5 max. Co; 0.5 max. Ni	B, CR, D, HR	
51	**Berylco 25**	Beryllium Corp., Reading, Pa.	Cu; 1.9–2.15 Be; 0.05–0.4 Co; 0.1 max. Fe; 0.15 max. Si	B, C, CR, HR, P, S, R, T, W	C
52	**Borod**	Stoody Co., Whittier, Calif.	60 tungsten carbide; 40 steel	Welding rod	A
53	**Brass, Aluminum**	Generally available[1]	76 Cu; 21.5–22 Zn; 2–2.5 Al	CR, D, T	
54	**Brass, Cartridge**	Generally available[1] (Corrosion data by Amer. Brass)	66.5–69.5 Cu; 30.5–33.5 Zn	B, P, S, R, T, W	C
55	**Brass, Forging**	Scoville Mfg. Co., Waterbury, Conn.	59 Cu; 2 Pb; bal. Zn	R, W	C
56	**Brass, Free Cutting**	Scoville Mfg. Co., Waterbury, Conn.	61.5 Cu; 3 Pb; bal. Zn	R, W	C
57	**Brass, High**	Generally available[1]	66 Cu; 34 Zn		C
58	**Brass, Low Leaded**	Scoville Mfg. Co., Waterbury, Conn.	65 Cu; 0.5 Pb; bal Zn	S, T, W	C
59	**Brass, Med. Leaded**	Scoville Mfg. Co., Waterbury, Conn.	65 Cu; 0.9 Pb; bal. Zn	S, R, W	C
60	**Brass, High Leaded**	Scoville Mfg. Co., Waterbury, Conn.	63 Cu; 1.75 Pb; bal. Zn	S, R, W	C
61	**Brass, Naval**	Generally available[1] (Corrosion data by Amer. Brass)	60 Cu; 39.25 Zn; 0.75 Sn	B, P, S, R, W, D, R, T	C
62	**Brass, Naval, Low Leaded**	Scoville Mfg. Co., Waterbury, Conn.	61 Cu; 0.75 Sn; 0.75 Pb; bal. Zn (Corrosion resistance same as 61)	R, W	C
63	**Brass, Red**	Generally available[1] (Corrosion data by Chase, Amer. Brass)	85 Cu; 15 Zn	B, S, R, T, W, P	C
65	**Bronze, Aluminum**	Generally available[1]	82–95 Cu; 5–10 Al; Fe; Mn; Ni; Sn	C, CR, F, HR, P, R, S, T, W	C
66	**Bronze, Commercial**	Chase Brass & Copper Co., Waterbury, Conn.	90 Cu; 10 Zn	P, S, T, W	C
67	**Bronze, 600 Forgeable Bearing**	Mueller Brass Co., Port Huron, Mich.	58 Cu; 2.5 Mn; 1.5 Al; 0.7 Si; bal. Zn	B, D, R, F	C, A
68	**Bronze, Gilding 95%**	Scoville Mfg. Co., Waterbury, Conn.	95 Cu; 5 Zn (Corrosion resistance same as commercial bronze)	S, R, T, W	C
69	**Bronze, Hardware**	Scoville Mfg. Co., Waterbury, Conn.	89 Cu; 8 Zn; 2 Pb; 1 Ni	D, R, W	C
70	**Bronze, High Leaded Tin**	Mueller Brass Co., Port Huron, Mich.	80 Cu; 10 Pb; 10 Sn	C	C
71	**Bronze, Manganese**	Mueller Brass Co., Port Huron, Mich.	58 Cu; 1 Sn; 1.4 Fe; 0.25 Mn; bal. Zn	B, D, R, F	C
72	**Bronze, High Strength Manganese**	Mueller Brass Co., Port Huron, Mich.	65 Cu; 3 Fe; 4 Mn; 5 Al; bal. Zn		
73	**Bronze, Phosphor, 5% A**	Generally available[1] (Corrosion data by Amer. Brass)	94.8–95.5 Cu; 4.3–5 Sn; P	B, S, R, W, P, CR, D, T	C
74	**Bronze, Phosphor, 8% C**	Generally available[1] (Corrosion data by Amer. Brass)	Cu; 7–9 Sn; 0.03–0.25 P	B, S, R, T, W, P, CR, D	C
75	**Bronze, Phosphor, 10% D**	Generally available[1] (Corrosion data by Amer. Brass)	89.5–90 Cu; 10–10.5 Sn; P	B, S, R, T, W, P, CR, D	C
76	**Bronze, Phosphor, Special Free Cutting**	Amer. Brass Co., Waterbury, Conn.	88 Cu; 4 Zn; 4 Sn; 4 Pb	B, S, R, P	C
77	**Bronze, Tobin**	Amer. Brass Co., Waterbury, Conn.	60 Cu; 39.25 Zn; 0.75 Sn	B, S, R, T, W, P, D, HR, CR	C
78	**Bronze, Tobin**	Mueller Brass Co., Port Huron, Mich.	60 Cu; 1 max. Sn; bal. Zn		C
79	**Buflokast Gray Iron**	Buflovak Equipment Div., Blaw-Knox Co., Buffalo, N. Y.	Fe; 3.2–3.6 C; 2 max. Ni; 1–2 Si; 0.6–0.9 Mn	C	
80	**CA Stainless**	Cooper Alloy Fdry. Co., Hillside, N. J.	Various standard stainless steels; see Nos. 275–360	C	C
81	**CA-FA20**	Cooper Alloy Fdry. Co., Hillside, N. J.	Fe; 19–21 Cr; 28–30 Ni; 3.5 Mo; 4–4½ Cu; 0.07 max. C	C	C
82	**CA-MM**	Cooper Alloy Fdry. Co., Hillside, N. J.	67 Ni; 30 Cu; 1.4 Fe; 0.1 Si; 0.15 C	C	C
83	**Calite A**	Calorizing Co., Wilkinsburg, Pa.	Fe; 35 Ni; 15 Cr	B, C, P, S, R, W	H
84	**Calite B28**	Calorizing Co., Wilkinsburg, Pa.	Fe; 25 Cr; 10 Ni; 1 Mo	C	H
85	**Cast Iron**	Corrosion data from *Standards of Hydraulic Institute*, Section G, 1941, Hydraulic Inst., New York	All-cast-iron pumps		
86	**Cast Iron**	Corrosion data from *Circular No. 312*, 1939, Crane Co., Chicago	Cast iron valves		
87	**Causul Metal**	Lunkenheimer Co., Cincinnati, Ohio	Fe; 19 Ni; 2.2–2.8 C; 4 Cu; 1.5 Cr	C	C
88	**Chlorimet 2**	Duriron Co., Dayton, Ohio	63 Ni; 32 Mo; 3 max. Fe; 0.15 max. C; 1 Si; 1 Mn	C	C
89	**Chlorimet 3**	Duriron Co., Dayton, Ohio	60 Ni; 18 Mo; 18 Cr; 2 Fe; 0.07 max. C; 1 Si; 1 Mn	C	C
90	**Chromax**	Driver Harris Co., Harrison, N. J.	Fe; 19 Cr; 35 Ni	B, CR, HR, P, R, S, W	H
91	**Chromel A**	Hoskins Mfg. Co., Detroit, Mich.	80 Ni; 20 Cr	B, CR, HR, D, R, W	H
92	**Chromel C and D**	Hoskins Mfg. Co., Detroit, Mich.	35–61 Ni; 16–18½ Cr; 23–46½ Fe		
93	**Chromel P**	Hoskins Mfg. Co., Detroit, Mich.	90 Ni; 10 Cr	CR, W	H
94	**Circle L Stainless**	Lebanon Steel Fdry., Lebanon, Pa	Various standard stainless steels; see Nos. 275–360	C	C, A
95	**Circle L 13**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 13 Cr; 0.25 max. C; 0.75 Mn; 0.75 max. Ni; 0.4 Mo	C	C, A

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
96	**Circle L 21**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 19 Cr; 9 Ni; 0.07 max. C; 0.75 Mn; 0.75 Cb	C	C
97	**Circle L 22M**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 19 Cr; 9 Ni; 0.07 max. C; 0.75 Mn; 1.75 Mo; 0.25 Se	C	C
98	**Circle L 22XM**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 20 Cr; 10 Ni; 0.07 max. C; 0.75 Mn; 3 Mo	C	C
99	**Circle L 23XM**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 19 Cr; 9 Ni; 0.2 max. C; 0.75 Mn; 3 Mo	C	C
100	**Circle L 24**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 10 Cr; 20 Ni; 0.2 max. C; 0.75 Mn	C	C
101	**Circle L 30H**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 24 Cr; 12 Ni; 0.5 max. C; 0.75 Mn	C	H
102	**Circle L 31**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 29 Cr; 9 Ni; 0.3 max. C; 0.75 Mn	C	C
103	**Circle L 31H**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 29 Cr; 9 Ni; 0.5 max. C; 0.75 Mn	C	H
104	**Circle L 32**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 15 Cr; 35 Ni; 0.5 max. C; 0.75 Mn	C	H
105	**Circle L 32XMC**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 15 Cr; 35 Ni; 0.07 max. C; 3.25 Mo; 2.25 Cu; 0.75 Mn	C	C
106	**Circle L 34**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 21 Cr; 29 Ni; 0.07 max. C; 3.25 Mo; 0.75 Mn	C	C
107	**Circle L 41**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; 15 Cr; 65 Ni; 0.5 max. C; 0.5 Mn	C	H
108	**Colmonoy**	Wall-Colmonoy Corp., Detroit, Mich.	68–80 Ni; 7–19 Cr; 2–4 B; Fe; Si	B, C, R	C, H, A
109	**Colonial 618**	Vanadium Alloys Steel Co., Latrobe, Pa.	Fe; 16–18 Cr; 1 Ni; 0.12 max. C; S (optional)	B, D, HR, P, R, S, W	C
110	**Capel**	Hoskins Mfg. Co., Detroit, Mich.	55 Cu; 45 Ni	B, CR, HR, D, P, W	C, H
111	**Copper**	Generally available[1] (Corrosion data by Chase)	99.9 + Cu	B, P, S, R, T, W	C
112	**Copper, Beryllium**	Generally available[1]	97.5 Cu; 2.15 Be; 0.35 Ni	B, C, CR, D, HR, P, R, S, W	C
113	**Copper, Cadmium**	Phelps Dodge Copper Prod. Corp., New York, N. Y.	99 Cu; 1 Cd	B, CR, D, HR, R, W	
114	**Copper, Deoxidized**	Generally available[1] (Corrosion data by Amer. Brass)	99.9+ Cu; 0.01–0.03 P	B, C, CR, D, HR, P, R, S, T	C
115	**Copper, O.F.H.C.**	Amer. Metal Co., New York, N. Y.	99.9+ Cu	B, C, CR, D, HR, P, R, S, T, W	C
116	**Copper, P.D.C.P.**	Phelps Dodge Copper Prod. Corp., New York, N. Y.	99.9+ Cu	B, C, D, CR, HR, R, T, W	C
117	**Copper, Phosphorized**	Mueller Brass Co., Port Huron, Mich.	99.9 Cu; trace P	T	C
118	**Copper, Tellurium**	Chase Brass & Copper Co., Waterbury, Conn.	99.5 Cu; 0.5 Te	B, R, T, W	C
119	**Corrosiron**	Pacific Fdry. Co. Ltd., San Francisco, Calif.	Fe; 14.5 Si	C	C
120	**Croloy Stainless**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Various standard stainless steels; see Nos. 275–360	T	C, H
121	**Cupaloy**	Westinghouse Electric Corp., Pittsburgh, Pa.	99.4 Cu; 0.1 Ag; 0.5 Cr	B, C, R	C
122	**Cupron**	Wilbur B. Driver Co., Newark, N. J.	Cu; 45 Ni	B, CR, D, HR	
123	**Cupro-Nickel, 20%**	Generally available[1] (Corrosion data by Amer. Brass)	70 Cu; 20 Ni	B, P, S, R, T, W	C
124	**Cupro-Nickel, 30%**	Generally available[1] (Corrosion data by Chase)	70 Cu; 30 Ni	B, C, CR, D, HR, P, R, S, T, W	C
125	**Disston Stainless**	Henry Disston & Sons Inc., Philadelphia, Pa.	Various standard stainless steels; see Nos. 275–360	B, HR, P	C, H, A
126	**Doppley 30**	Bowers Mfg. Co., Buffalo, N. Y.	Fe; 18.5 Ni; 2.35 Cr; 2.85 C; 1 Mn	C	C
127	**Dowmetal C**	Dow Chemical Co., Midland, Mich.	Mg; 9 Al; 2 Zn; 0.1 Mn	C (perm. mold)	C
128	**Dowmetal FS-1**	Dow Chemical Co., Midland, Mich.	Mg; 3 Al; 1 Zn; 0.3 Mn	B, E, P, S, R, T	C
129	**Dowmetal H**	Dow Chemical Co., Midland, Mich.	Mg; 6 Al; 3 Zn; 0.2 Mn	C (sand)	C
130	**Dowmetal J-1**	Dow Chemical Co., Midland, Mich.	Mg; 6.5 Al; 1 Zn; 0.2 Mn	B, E, P, S, R, T, F	C
131	**Dowmetal M**	Dow Chemical Co., Midland, Mich.	Mg; 1.5 Mn	B, E, P, S, R, T, F	C
132	**Dowmetal O-1**	Dow Chemical Co., Midland, Mich.	Mg; 8.5 Al; 0.5 Zn; 0.2 Mn	B, E, R, F	C
133	**Dowmetal R**	Dow Chemical Co., Midland, Mich.	Mg; 9 Al; 0.6 Zn; 0.2 Mn	C (die)	C
134	**Duraloy Stainless**	Duraloy Co., Scottdale, Pa.	Various standard stainless steels; see Nos. 275–360	C, T (centrifugal)	C, H, A
135	**Duraloy**	Duraloy Co., Scottdale, Pa.	Fe; 26–30 Cr; 3 Ni; 2.75 C	C, T (centrifugal)	A
136	**Duraloy HCA**	Duraloy Co., Scottdale, Pa.	Fe; 26–30 Cr; 1 C	C, T (centrifugal)	C, A
137	**Duraloy HCN**	Duraloy Co., Scottdale, Pa.	Fe; 25 Cr; 12 Ni; 1 C	C, T (centrifugal)	C, H, A
138	**Durco Stainless**	Duriron Co., Dayton, Ohio	Various standard stainless steels; see Nos. 275–360	C	C, H, A
139	**Durco D-10**	Duriron Co., Dayton, Ohio	57 Ni; 23 Cr; 8 Cu; 4 Mo; 2 W; 1 Mn	C	C
140	**Durichlor**	Duriron Co., Dayton, Ohio	Fe; 0.85 C; 14.5 Si; 3 Mo; 0.35 Mn	C	C
141	**Durimet 20**	Duriron Co., Dayton, Ohio	Fe; 20 Cr; 29 Ni; 0.07 max. C; 2 Mo; 4 Cu; 1 Si	C	C
142	**Durimet T**	Duriron Co., Dayton, Ohio	Fe; 19 Cr; 22 Ni; 0.07 max. C; 2 Mo; 1 Cu; 1 Si	C, HR, B	C
143	**Duriron**	Duriron Co., Dayton, Ohio	Fe; 0.80 C; 14.5 Si; 0.35 Mn	C	C
144	**Elverite A**	Babcock & Wilcox Co., New York, N. Y.	Fe; 3–3.5 C; 0.35 Mn; 0.25–1 Si	C	A
145	**Elverites B and C**	Babcock & Wilcox Co., New York, N. Y.	Fe; 3–3.5 C; 1–1.8 Cr; 3.75–4.75 Ni; 0.25–1 Si	C	A
147	**Enduro Stainless**	Republic Steel Corp., Cleveland, Ohio	Various standard stainless steels; see Nos. 275–360	B, HR, D, CR, S, C, P, R, T, W, strip	C, H
148	**Everdur 1000**	Amer. Brass Co., Waterbury, Conn.	94.9 Cu; 4 Si; 1.1 Mn	Casting ingots	C
149	**Everdur 1010**	Amer. Brass Co., Waterbury, Conn.	95.8 Cu; 3.1 Si; 1.1 Mn	B, P, S, R, T, W	C
150	**Everdur 1015**	Amer. Brass Co., Waterbury, Conn.	98.25 Cu; 1.5 Si; 0.25 Mn	B, P, S, R, T, W	C
151	**Fahrite Stainless**	Ohio Steel Fdry. Co., Cincinnati, Ohio	Various standard stainless steels; see Nos. 275–360	C	C, H, A
152	**Frontier 5**	Frontier Bronze Corp., Niagara Falls, N. Y.	89 Cu; 10 Al; 1 Fe	C	C
153	**Frontier 11**	Frontier Bronze Corp., Niagara Falls, N. Y.	88 Cu; 5 Ni; 5 Sn; 2 Zn	C	C
154	**Frontier 40**	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu; 5 Zn; 0.5 Mg; 0.5 Cr; 0.2 Ti	C	C
155	**Genesee Stainless**	Symington-Gould Corp., Rochester, N. Y.	Various standard stainless steels; see Nos. 275–360	C	C, H, A
156	**Gold**	Baker & Co. Inc., Newark, N. J.	99.99 Au	B, C, CR, HR, D, P, S, R, T, W	C
157	**Gun Metal**	Mueller Brass Co., Port Huron, Mich.	88 Cu; 10 Sn; 2 Zn	C	C
158	**Hascrome**	Haynes Stellite Co., Kokomo, Ind.	Fe; 10–14 Cr; 0.8–1.2 C; 3–5 Mn	C, R (rolled, extruded)	H, A
159	**Hastelloy A**	Haynes Stellite Co., Kokomo, Ind.	Ni; 17–21 Mo; 17–21 Fe	B, C, CR, HR, D, P, S, R, T, W	C, H
160	**Hastelloy B**	Haynes Stellite Co., Kokomo, Ind.	Ni; 24–32 Mo; 3–7 Fe; 0.02–0.12 C	B, C, CR, HR, D, P, S, R, T, W	C, H
161	**Hastelloy C**	Haynes Stellite Co., Kokomo, Ind.	Ni; 14–19 Mo; 4–8 Fe; 0.04–0.15 C; 12–16 Cr; 3–5.5 W	B, C, CR, HR, D, P, S, R, T, W	C, H, A
162	**Hastelloy D**	Haynes Stellite Co., Kokomo, Ind.	Ni, 8–11 Si; 2–5 Cu; 1 max. Al	C, R	C, H, A

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
163	Haynes Stellite 1	Haynes Stellite Co., Kokomo, Ind.	Co; 28-34 Cr; 11-15 W	R (cast)	C, H, A
164	Haynes Stellite 3	Haynes Stellite Co., Kokomo, Ind.		C	C, H, A
165	Haynes Stellite 6	Haynes Stellite Co., Kokomo, Ind.	Co; 25-31 Cr; 3-6 W	C, S, R (cast)	C, H, A
166	Haynes Stellite 12	Haynes Stellite Co., Kokomo, Ind.	Co; 26-32 Cr; 6-10 W	C, R (cast)	C, H, A
167	Haynes Stellite 21	Haynes Stellite Co., Kokomo, Ind.	Co; 25-30 Cr; 4.5-6.5 Mo; 1.5-3.5 Ni; 2 max. Fe; 0.2-0.35 C	C, S	C, H
168	Haynes Stellite 23	Haynes Stellite Co., Kokomo, Ind.	Co; 0.35-0.5 C; 23-29 Cr; 1.5 max. Ni; 4-7 W; 2 max. Fe	C, S	C, H
169	Haynes Stellite 27	Haynes Stellite Co., Kokomo, Ind.	Ni; 0.35-0.5 C; 23-29 Cr; 5-7 Mo; 2 max. Fe; 30 min. Co	C, S	C, H
170	Haynes Stellite 30	Haynes Stellite Co., Kokomo, Ind.	Co; 3.5-5 C; 23-29 Cr; 13-17 Ni; 5-7 Mo; 2 max. Fe	C, S	C, H
171	Haynes Stellite 31	Haynes Stellite Co., Kokomo, Ind.	Co; 0.45-0.6 C; 23-28 Cr; 9-12 Ni; 6-9 W; 1.5 max. Fe	C, S	C, H
173	Haynes Stellite 93	Haynes Stellite Co., Kokomo, Ind.	Fe; 15-19 Cr; 4-7 Co; 0.5-3 V; 13-17 Mo	C, R	H, A
174	Haynes Stellite 98M2	Haynes Stellite Co., Kokomo, Ind.	Co; 27-31 Cr; 16-19 W	C	C, H, A
175	Haynes Stellite Multimet	Haynes Stellite Co., Kokomo, Ind.	20 Cr; 20 Co; 20 Ni; 3 Mo; 2 W; 1 Cb; 0.14 N; 0.1-0.35 C	B, C, CR, HR, D, P, S, R, T, W	C, H
176	Haynes Stellite Stainless	Haynes Stellite Co., Kokomo, Ind.	Various standard stainless steels; see Nos. 275-360	C	C, H, A
177	Haynes Stellite Star J	Haynes Stellite Co., Kokomo, Ind.	Co; 29-34 Cr; 15-19 W	C	C, H, A
178	Haystellite, Hard Grade	Haynes Stellite Co., Kokomo, Ind.	90-96 W; 0.5-2 Co; 3.5-4.5 C	R, crushed grains	A
179	Haystellite, Tough Grade	Haynes Stellite Co., Kokomo, Ind.	79-85 W; 8-11 Co; 3.5-4.5 C	Cast inserts, crushed grains	A
180	Herculoy A and B	Revere Copper and Brass, New York, N. Y.	96-98 Cu; 1.75-3 Si; 0.25-0.5 Sn	B, CR, D, HR, P, R, S, T, W	C
181	Hytensl	Amer. Manganese Bronze Co., Philadelphia, Pa.	63 Cu; 23 Zn; 4 Al; 3 Fe; 3 Mn	B, C, HR, R	C, A
182	Illium G	Burgess-Parr Co., Freeport, Ill.	56 Ni; 22 Cr; 6 Mo; 6 Fe; 6 Cu; Mn; Si; C	C	
183	Illium R	Burgess-Parr Co., Freeport, Ill.	55-60 Ni; 18-24 Cr; 5-8 Mo; 5-8 Fe; 2-6 Cu; 0.5-1.75 Mn; Si; C	B, C, CR, P, R, S, T, W	
184	Inconel	International Nickel Co., New York, N. Y.	79.5 Ni; 13 Cr; 6.5 Fe; 0.08 C; 0.2 Cu; 0.25 Mn	B, C, CR, HR, D, P, S, R, T, W	C, H
185	Inconel-Clad Steel	Lukens Steel Co., Coatesville, Pa.	Steel sheet clad on one or both sides.	HR, P, heads	C
186	Indium Metal	Amer. Smelting and Ref. Co., New York, N. Y.	In	B, C, CR, R, S, T, W	C
187	Ingersoll Stainless	Ingersoll Steel Div., Borg-Warner Corp., Chicago, Ill.	Various standard stainless steels; see Nos. 275-360	P, S	C, H
188	Iso Cast Stainless	Empire Steel Castings, Inc., Reading, Pa.	Various standard stainless steels; see Nos. 275-360	C	C, H, A
189	K42B	Westinghouse Electric Corp., Pittsburgh, Pa.	42 Ni; 22 Co; 18 Cr; 14 Fe; 2.2 Ti	B, CR, R, W, F	H
190	Kanthal Alloys	C. O. Jelliff Mfg. Corp., Southport, Conn.	Fe; 20-25 Cr; Co; Al	W, ribbon	H
191	Lead	Eagle-Picher Co., Cincinnati, Ohio	99.9+ Pb	B, C, CR, S, R, T, W	C
192	Lead, Antimonial	Amer. Smelting & Ref. Co., New York, N. Y.	94 Pb; 6 Sb	C, CR, D, R, S, T, W	C
193	Lead, Antimonial	National Lead Co., New York, N. Y.	Pb; 4-12 Sb	B, C, CR, S, R, T, W, pipe	C
194	Lead, Antimonial	Northwest Lead Co., Seattle, Wash.	93.45 Pb; 6.5 Sb; 0.04-0.08 Cu	C, S, T, W	C
195	Lead, Chemical	Amer. Smelting & Ref. Co., New York, N. Y.	99.93 Pb; 0.06 Cu	B, C, CR, R, S, T, W	C
196	Lead, Chemical	National Lead Co., New York, N. Y.	99.93 Pb; 0.06 Cu	B, C, CR, S, R, T, W, pipe	C
197	Lead, Chemical	Northwest Lead Co., Seattle, Wash.	99.95 Pb; 0.04-0.08 Cu	C, S, T, W	C
198	Lead, Chemical Tellurium	Northwest Lead Co., Seattle, Wash.	99.9 Pb; 0.02-0.06 Te; 0.04-0.08 Cu	C, S, T, W	C
199	Lead, Tellurium	Amer. Smelting & Ref. Co., New York, N. Y.	99.88 Pb; 0.045 Te; 0.06 Cu	B, C, CR, R, S, T, W	C
200	Lead, Tellurium	National Lead Co., New York, N. Y.	99.88 Pb; 0.045 Te; 0.06 Cu	B, C, CR, R, S, T, W, pipe	C
201	Lukens CrCuNi Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.1 max. C; 0.4-0.6 Mn; 0.4-0.6 Cr; 0.4-0.6 Cu; 0.4-0.8 Ni	HR, P, heads	C
202	Lukens CrNiMo Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.25 max. C; 0.7-0.9 Mn; 0.8-1 Ni; 0.3-0.5 Mo	HR, P, heads	H, A
203	Lukens CrMn Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.45 max. C; 0.8-1 Mn; 0.3-0.5 Cr	HR, P, heads	H, A
204	Lukens CrMo Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.45 max. C; 0.3-0.6 Mn; 0.4-0.6 Cr; 0.3-0.6 Mo	HR, heads	H
205	Lukens MnMo Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.2 max. C; 1.2-1.5 Mn; 0.4-0.6 Mo	HR, P, heads	H, A
206	Lukens MnV Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.2 max. C; 1-1.4 Mn; 0.12 max. V	HR, P, heads	H
207	Lukens ½Mo Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.2 max. C; 0.6-0.9 Mn; 0.4-0.6 Mo	P, heads	H
208	Lukens 8½ Ni Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.12 max. C; 0.5-0.8 Mn; 8-9 Ni	HR, P, heads	C
209	Lukens NiCr Steel	Lukens Steel Co., Coatesville, Pa.	Fe; 0.2 max. C; 0.4-0.6 Mn; 1-1.2 Ni; 0.4-0.6 Cr	HR, P, heads	H, A
210	Mayari R	Bethlehem Steel Co., Bethlehem, Pa.	Fe; 0.12 max. C; 0.2-1 Cr; 0.25-0.75 Ni; 0.5-0.7 Cu; 0.5-1 Mn	B, CR, HR, P, R, S, T, W	A
211	Michiana Stainless	Michiana Products Corp., Michigan City, Ind.	Various standard stainless steels; see Nos. 275-360	C	H
212	Midvaloy Stainless	Midvale Co., Philadelphia, Pa.	Various standard stainless steels; see Nos. 275-360		
213	Milwaukee Stainless	Milwaukee Steel Fdry., Milwaukee, Wis.	Various standard stainless steels; see Nos. 275-360	C	C, H, A
214	Misco Stainless	Michigan Steel Casting Co., Detroit, Mich.	Various standard stainless steels; see Nos. 275-360	C	C, H, A
215	Miscrome Stainless	Michigan Steel Casting Co., Detroit, Mich.	Various standard stainless steels; see Nos. 275-360	C	C, H, A
216	Monel	International Nickel Co., New York, N. Y.	67 Ni; 30 Cu; 1.4 Fe; 0.1 Si; 0.15 C	B, C, CR, D, HR, P, R, S, T, W	C
217	Monel-Clad	Lukens Steel Co., Coatesville, Pa.	Steel sheet clad on one or both sides.	HR, P, heads	C
218	Mueller 85-5-5-5	Mueller Brass Co., Port Huron, Mich.	85 Cu; 5 Zn; 5 Sn; 5 Pb	C	C
219	Muntz Metal	Generally available[1] (Corrosion data by Amer. Brass)	60 Cu; 40 Zn	B, P, S, R, T, W	C
220	National Al Alloys	National Smelting Co., Cleveland, Ohio	Al; 0-4 Cu; 0-4 Mg; 0-7.5 Si; 0-0.6 Mn; 0-1.5 Ni	C	C
221	Niag	Mueller Brass Co., Port Huron, Mich.	46 Cu; 10 Ni; 2.5 Pb; bal. Zn	B, D, R, F	C
222	Nichrome	Driver Harris Co., Harrison, N. J.	60 Ni; 15 Cr; Fe	B, CR, HR, P, R, S, T, W	H
223	Nichrome V	Driver Harris Co., Newark, N. J.	80 Ni; 20 Cr	B, CR, D, HR, P, R, S, T, W	H
224	Nickel	International Nickel Co., New York, N. Y.	99.4 Ni; 0.2 Mn; 0.1 Cu; 0.15 Fe; 0.05 Si	B, C, CR, HR, D, P, R, S, T, W	C, H
225	Nickel-Clad	Lukens Steel Co., Coatesville, Pa.	Steel sheet clad on one or both sides.	HR, P, heads	C
226	Nickel Silver, 18% A	Generally available[1] (Corrosion data by Amer. Brass)	65 Cu; 18 Ni; 17 Zn	B, C, CR, D, P, R, S, T, W	C

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
227	**Nickel Silver, 18% B**	Generally available [1]	55 Cu; 18 Ni; 27 Zn	B, C, CR, D, P, R, S	C
228	**Nicloy**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; 3½, 5, or 9 Ni	T (seamless)	C
229	**Ni-Hard**	International Nickel Co., New York, N. Y.	Fe; 3.4 C; 1.5 Cr; 4.5 Ni; 0.6 Si	C	A
230	**Nilstain**	Wilbur B. Driver Co., Newark, N. J.	Fe; 18-20 Cr; 8-10 Ni; 0.2 max. C; 2 max. Mn	D, HR, R, W	C
231	**Ni-Resist**	International Nickel Co., New York, N. Y.	Fe; 2.8 C; 14 or 20 Ni; 6 Cu (optional); 2 Cr; 2 Si	C	C, H
232	**Nirex**	Driver-Harris Co., Harrison, N. J.	80 Ni; 14 Cr; 6 Fe	B, CR, HR, P, R, S, W	H
233	**NS-5 Alloy**	Lunkenheimer Co., Cincinnati, Ohio	50 Ni; 46 Cu; 2.4 Si; 1.6 Mn	C (valve seats, discs)	C, H, A
234	**Olympic Bronze, Type A**	Chase Brass & Copper Co., Waterbury, Conn.	96 Cu; 3 Si; 1 Zn	P, S, R, T, W	C
235	**Olympic Bronze, Type B**	Chase Brass & Copper Co., Waterbury, Conn.	97.5 Cu; 1.5 Si; 1 Zn	P, S, R	C
236	**Palladium**	Baker & Co., Newark, N. J.	99.991 Pd	B, C, CR, HR, D, P, S, R, T, W	C, H
237	**Pennalloy**	Pennsylvania Elec. Steel Casting Co., Hamburg, Pa.		C	A
238*	**Permite Al Alloys**	Aluminum Industries, Cincinnati, Ohio	Al; 0-5 Cu; 1.5-7.5 Si; 0-1 Fe; 0-0.4 Mg	C	C
239	**Pioneer**	Pioneer Alloy Products Co., Cleveland, Ohio	65 Ni; Cr; Mo; Fe	C	C
240	**Platinum**	Baker & Co., Newark, N. J.	99.99 Pt	B, C, CR, HR, D, P, S, R, T, W	C, H
241	**Platinum**	J. Bishop & Co., Malvern, Pa.	99.95 Pt	B, C, CR, HR, D, P, S, R, T, W	C, H
242	**Platinum, Iridio**	Baker & Co., Newark, N. J.	Pt; 5-30 Ir	B, CR, HR, C, D, P, S, R, T, W	C, H
243	**Platinum, Iridium**	J. Bishop & Co., Malvern, Pa.	Pt; 10-30 Ir	B, CR, HR, C, D, P, S, R, T, W	C, H
244	**Platinum, Rhodio**	Baker & Co., Newark, N. J.	Pt; 5-40 Rh	B, C, CR, HR, D, P, S, R, T, W	C, H
245	**Pyrasteel**	Chicago Steel Fdry. Co., Chicago, Ill.	Fe; 25-27 Cr; 12-14 Ni; 0.1-0.35 C; Mo, Cb, Se (optional)	C	C, H
246	**Pyrocast**	Pacific Fdry. Co. Ltd., San Francisco, Calif.	Fe; 22-30 Cr	C	H
247	**Pyrocast Stainless**	Pacific Fdry. Co. Ltd., San Francisco, Calif.	Various standard stainless steels; see Nos. 275-360	C	H
249	**Resistac**	Amer. Manganese Bronze Co., Philadelphia, Pa.	88 Cu; 10 Al; 2 Fe	B, C, HR, R	C, H
250	**Reynolds 2S**	Reynolds Metals Co., Louisville, Ky.	99 Al; 1 max. Fe + Si; 0.2 max. Cu	B, R, W	C
251	**Reynolds 3S**	Reynolds Metals Co., Louisville, Ky.	Al; 1-1.5 Mn; 0.7 max. Fe; 0.6 max. Si; 0.2 Cu	B, R, W	C
252	**Reynolds 14S**	Reynolds Metals Co., Louisville, Ky.	Al; 3.9-5 Cu; 0.5-1.2 Si; 1 max. Fe; 0.4-1.2 Mn; 0.2-0.8 Mg	B, R, W	C
253	**Reynolds 17S**	Reynolds Metals Co., Louisville, Ky.	Al; 3.5-4.5 Cu; 0.8 max. Si; 1 max. Fe; 0.4-1 Mn; 0.2-0.8 Mg	B, R, W	C
254	**Reynolds 18S**	Reynolds Metals Co., Louisville, Ky.	Al; 3.5-4.5 Cu; 1.7-2.3 Ni; 0.9 max. Si; 1 max. Fe; 0.45-0.9 Mg	B, R, W	C
255	**Reynolds 24S**	Reynolds Metals Co., Louisville, Ky.	Al; 3.8-4.9 Cu; 1.2-1.8 Mg; 0.5 max. Si	B, R, W	C
256	**Reynolds 24S Pureclad**	Reynolds Metals Co., Louisville, Ky.	Al 24S core covered with Al of high purity	S, P	C
257	**Reynolds 25S**	Reynolds Metals Co., Louisville, Ky.	Al; 3.9-5 Cu; 0.5-1.2 Si; 1 max. Fe	B, R, W	C
258	**Reynolds 32S**	Reynolds Metals Co., Louisville, Ky.	Al; 11-13.5 Si; 0.5-1.3 Cu; 1.0 max. Fe; 0.8-1.3 Mg; 0.5-1.3 Ni	B, R, W	C
259	**Reynolds A51S**	Reynolds Metals Co., Louisville, Ky.	Al; 0.6-1.2 Si; 1 max. Fe; 0.35 Cu; 0.45-0.8 Mg	B, R, W	C
260	**Reynolds 52S**	Reynolds Metals Co., Louisville, Ky.	Al; 2.2-2.8 Mg; 0.45 max. Fe + Si; 0.1 max. Cu	B, R, W	C
261	**Reynolds 53S**	Reynolds Metals Co., Louisville, Ky.	Al; 0.35 max. Fe; 1.1-1.4 Mg; 0.15-0.35 Cr	B, R, W	C
262	**Reynolds 61S**	Reynolds Metals Co., Louisville, Ky.	Al; 0.4-0.8 Si; 0.7 max. Fe; 0.8-1.2 Mg	B, R, W	C
263	**Reynolds R301**	Reynolds Metals Co., Louisville, Ky.	High strength Al alloy core clad with corrosion resistant Al alloy of intermediate strength.	S, P	C
264	**Rezistal Stainless**	Crucible Steel Co. of Amer., New York, N. Y.	Various standard stainless steels; see Nos. 275-360	B, CR, HR, D, P, S, R, W	C, H, A
265	**Ruefley**	Amer. Smelting & Ref. Co., New York, N. Y.	Pb; 0.25 Sn; 0.02 Mg; 0.02 Bi	CR, R, T	C
266	**St. Joe Lead**	St. Joseph Lead Co., New York, N. Y.	99.90 + Pb; 0.04-0.08 Cu; 0.002-0.02 Ag; 0.002 max. Fe; 0.001 max. Zn; 0.002 max. As, Sb, Sn	Pigs	C
267	**Silfram**	Stoody Co., Whittier, Calif.	Fe; 30 Cr; 10 Ni	C, welding rod	A
268	**Silver**	Baker & Co. Inc., Newark, N. J.	99.9+ Ag	B, C, CR, HR, D, P, S, R, T, W	C
269	**Silver**	Handy & Harman, New York, N. Y.	99.9+ Ag	B, C, CR, D, P, R, S, T, W	C
270	**Stainless-Clad 304**	Lukens Steel Co., Coatesville, Pa.	Sheet steel clad on one or both sides.	HR, P, heads	C
271	**Stainless-Clad 316**	Lukens Steel Co, Coatesville, Pa.	Sheet steel clad on one or both sides.	HR, P, heads	C
272	**Stainless-Clad 347**	Lukens Steel Co., Coatesville, Pa.	Sheet steel clad on one or both sides.	HR, P, heads	C
273	**Stainless-Clad 410**	Lukens Steel Co., Coatesville, Pa.	Sheet steel clad on one or both sides.	HR, P, heads	C
274	**Stainless-Clad 430**	Lukens Steel Co., Coatesville, Pa.	Sheet steel clad on one or both sides.	HR, P, heads	C
275	**Stainless Type 301**		Fe; 16-18 Cr; 6-8 Ni; 0.08-0.15 C	B, CR, D, HR, P, S, W	C
276	**Stainless Type 302**	NOTE: Listed below are the producers of standard stainless steels (Nos. 275-305) for which type analyses have been established by the Amer. Iron and Steel Inst. The designations are intended to apply only to wrought products, but are so commonly applied to castings as well that they have been adopted by many foundries to identify comparable casting alloys. Types marked * are no longer in force but occasional reference is still made to them. Numbers in ( ) are the number of standard A.I.S.I. alloys for which the manufacturer has provided corrosion data; they are solely to acknowledge cooperation in the preparation of these tables and have no reference to the number of steels produced by any company.	Fe; 17-19 Cr; 8-10 Ni; 0.08-0.15 C	B, CR, D, HR, P, S, W, T, R	C
277	**Stainless Type 302B**		Fe; 17-19 Cr; 8-10 Ni; 0.08-0.15 C; 2-3 Si	B, CR, D, HR, P, S, W	C, H
278	**Stainless Type 303**		Fe; 17-19 Cr; 8-10 Ni; 0.15 max. C; 0.07 min. P, S, Se; 0.6 max. Zr, Mo; 2 max. Mn	B, CR, D, HR, P, S, W	C
279	**Stainless Type 304**		Fe; 18-20 Cr; 8-11 Ni; 0.08 max. C; 2 max. Mn	B, CR, D, HR, P, R, S, T, W	C
280	**Stainless Type 308**		Fe; 19-21 Cr; 10-12 Ni; 0.08 max. C	B, CR, D, HR, P, R, S, T, W	C
281	**Stainless Type 309**		Fe; 22-24 Cr; 12-15 Ni; 0.2 max. C	B, CR, D, HR, P, R, S, W	H, C
282	**Stainless Type 310**		Fe; 24-26 Cr; 19-22 Ni; 0.25 max. C	B, CR, D, HR, P, R, S, T, W	C, H
283	**Stainless Type 316**	Allegheny Ludlum Steel Corp., Pittsburgh, Pa. (25)	Fe; 16-18 Cr; 10-14 Ni; 0.1 max. C; 1.75-2.75 Mo	B, CR, D, HR, P, R, S, T, W	C, H
284	**Stainless Type 317***	Alloy Metal Wire Co., Prospect Park, Pa.	Fe; 17.5-20 Cr; 10-14 Ni; 0.1 max. C; 3-4 Mo	B, CR, HR, P, R, S, T, W	C, H
285	**Stainless Type 321**	Amer. Chain & Cable Co., Bridgeport, Conn. Amer. Rolling Mill Co., Middletown, Ohio (4)	Fe; 17-19 Cr; 8-11 Ni; Ti, 5xC min.	B, CR, D, HR, P, R, S, T, W	C, H
286	**Stainless Type 347**	Babcock & Wilcox Tube Co., Beaver Falls, Pa. (7) Bethlehem Steel Co., Bethlehem, Pa.	Fe; 17-19 Cr; 9-12 Ni; Cb, 10xC min.	B, CR, D, HR, P, R, S, T, W	C, H

No	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
287	Stainless Type 403	A. M. Byers Co., Pittsburgh, Pa. Carnegie-Illinois Steel Co., Pittsburgh, Pa. (4) Carpenter Steel Co., Reading, Pa.	Fe; 11.5–13 Cr; 0.15 max. C; (turbine quality)	B, CR, D, HR, P, R, S, T, W	C, A
288	Stainless Type 405	Cooper Alloy Fdry. Co., Elizabeth, N. J. (3)	Fe; 11.5–13.5 Cr; 0.08 max. C; 0.1–0.3 Al	B, CR, D, HR, P, S, W	C, H
289	Stainless Type 406	Copperweld Steel Co., Warren, Ohio	Fe; 12–14 Cr; 0.15 max. C; 3.5–4.5 Al	B, CR, D, HR, P, S, W	C
290	Stainless Type 410	Crucible Steel Co. of America, New York, N. Y. (4) Wilbur B. Driver Co., Newark, N. J.	Fe; 11.5–13.5 Cr; 0.15 max. C	B, CR, D, HR, P, R, S, T, W	C, A, H
291	Stainless Type 414	Eastern Stainless Steel Corp., Baltimore, Md.	Fe; 11.5–13.5 Cr; 1.25–2.5 Ni; 0.15 max. C	B, D, HR, P, R, S, W	C, A
292	Stainless Type 416	Firth Sterling Steel Co., McKeesport, Pa. Globe Steel Tubes Co., Milwaukee, Wis. Henry Disston & Sons, Philadelphia, Pa.	Fe; 12–14 Cr; 0.15 max. C; 0.07 min. P, S, Se; 0.6 max. Zr, Mo	B, CR, D, HR, P, R, S, T, W	C, A
293	Stainless Type 418*	Ingersoll Steel Div., Borg-Warner Corp., New Castle, Ind.	Fe; 12–14 Cr; 0.15 max. C; 2.5–3.5 W		C, H
294	Stainless Type 420	Jessop Steel Co., Washington, Pa.	Fe; 12–14 Cr; 0.15 min. C	B, CR, D, HR, P, R, S, W	C, A
295	Stainless Type 430	Joslyn Mfg. & Supply Co., Chicago, Ill.	Fe; 14–18 Cr; 0.12 max. C	B, CR, HR, P, R, S, T, W	C, H
296	Stainless Type 430F	Latrobe Electric Steel Co., Latrobe, Pa. McLouth Steel Corp., Detroit, Mich. Michiana Products Corp., Michigan City, Ind.	Fe; 14–18 Cr; 0.12 max. C; 0.07 min. P, S, Se; 0.6 max. Zr, Mo	B, CR, D, HR, R, W	C, H
297	Stainless Type 431	Midvale Co., Philadelphia, Pa.	Fe; 15–17 Cr; 1.25–2.5 Ni; 0.2 max. C	B, CR, D, HR, P, S, W	C, A, H
298	Stainless Type 440A	Pittsburgh Steel Co., Pittsburgh, Pa.	Fe; 16–18 Cr; 0.6–0.75 C; 0.75 max. Mo	B, CR, HR, D, P, S, R, W	C, A
299	Stainless Type 440B	Timken Roller Bearing Co., Canton, Ohio	Fe; 16–18 Cr; 0.75–0.95 C; 0.75 max. Mo	B, CR, HR, D, P, S, R, W	C, A
300	Stainless Type 440C	Republic Steel Corp., Cleveland, Ohio Rotary Electric Steel Corp., Detroit, Mich.	Fe; 16–18 Cr; 0.95–1.2 C; 0.75 max. Mo	B, CR, HR, D, P, S, R, W	C, A
301	Stainless Type 442	Sharon Steel Corp., Sharon, Pa.	Fe; 18–23 Cr; 0.25 max. C	B, CR, D, HR, P, R, S	H, C
302	Stainless Type 443	Stanley Works, New Britain, Conn. Summerill Tubing Co., Bridgeport, Pa. Superior Steel Corp., Carnegie, Pa.	Fe; 18–23 Cr; 0.2 max. C; 0.9–1.25 Cu	B, CR, D, HR, P, R, S, T, W	C
303	Stainless Type 446	Universal Cyclops Steel Corp., Bridgeville, Pa. Vanadium Alloys Steel Co., Latrobe, Pa. (5) Wallingford Steel Co., Wallingford, Conn.	Fe; 23–27 Cr; 0.35 max. C; 0.25 max. N	B, CR, D, HR, P, R, S, T, W	C, H
304	Stainless Type 501		Fe; 4–6 Cr; 0.1 min. C	B, CR, D, HR, P, R, S, T, W	C,
305	Stainless Type 502		4–6 Cr; 0.1 max. C	B, CR, D, HR, P, R, S, T, W	C
306	Stainless Type CA-15	NOTE: Listed below are the producers of standard cast stainless steel (Nos. 306-361) for which type analyses have been established by the Alloy Casting Institute. Designations marked * are no longer in force but occasional reference is still made to them. Numbers in ( ) are the number of standard A.C.I. alloys for which the company has provided corrosion data; they are solely to acknowledge cooperation in the preparation of these tables and have no reference to the number of steels produced by any company.	Fe; 11–14 Cr; 1 max. Ni; 0.15 max. C	C	C
307	Stainless Type CA-40		Fe; 11–14 Cr; 1 max. Ni; 0.2–0.4 C	C	C
308	Stainless Type CB-30		Fe; 18–22 Cr; 2 max. Ni; 0.3 max. C	C	C
309	Stainless Type CC-35*		Fe; 26–30 Cr; 4 max. Ni; 0.35 max. C	C	C
310	Stainless Type CC-50		Fe; 26–30 Cr; 4 max. Ni; 0.5 max. C	C	C
311	Stainless Type CD-10M*		Fe; 27–30 Cr; 3–6 Ni; 0.1 max. C; 2 max. Mo	C	C
312	Stainless Type CE-30		Fe; 26–30 Cr; 8–11 Ni; 0.3 max. C	C	C
313	Stainless Type CF-7		Fe; 18–20 Cr; 8–10 Ni; 0.07 max. C	C	C
314	Stainless Type CF-10		Fe; 18–20 Cr; 8–10 Ni; 0.1 max. C	C	C
315	Stainless Type CF-16	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; 18–20 Cr; 8–10 Ni; 0.16 max. C	C	C
316	Stainless Type CF-20	Amer. Cast Iron Pipe Co., Birmingham, Ala.	Fe; 18–20 Cr; 8–10 Ni; 0.2 max. C	C	C
317	Stainless Type CF-7Se	American Manganese Steel Div., American Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; 18–20 Cr; 8–10 Ni; 0.07 max. C; 0.2–0.35 Se	C	C
318	Stainless Type CF-7C		Fe; 18–20 Cr; 8–10 Ni; 0.07 max. C; 8xC-1 Cb	C	C
319	Stainless Type CF-7M	American Steel Castings Co., Newark, N. J.	Fe; 18–20 Cr; 8–10 Ni; 0.07 max. C; 1.5–3.5 Mo	C	C
320	Stainless Type CF-10M	Atlas Fdry. Co., Irvington, N. J.	Fe; 18–20 Cr; 8–10 Ni; 0.1 max. C; 1.5–3.5 Mo	C	C
321	Stainless Type CF-16M	Babcock & Wilcox Co., Barberton, Ohio	Fe; 18–20 Cr; 8–10 Ni; 0.16 max. C; 1.5–3.5 Mo	C	C
322	Stainless Type CF-7MC*	Calorizing Co., Wilkinsburg, Pa. Chicago Steel Fdry., Chicago, Ill. Cooper Alloy Fdry. Co., Elizabeth, N. J.	Fe; 18–20 Cr; 8–10 Ni; 0.07 max. C; 1.5–3.5 Mo; 8xC-1 Cb	C	C
323	Stainless Type CG-7	Crane Co., Chicago, Ill.	Fe; 20–22 Cr; 10–12 Ni; 0.07 max. C	C	C
324	Stainless Type CG-10	Driver Harris Co., Harrison, N. J.	Fe; 20–22 Cr; 10–12 Ni; 0.1 max. C	C	C
325	Stainless Type CG-16	Duraloy Co., Scottdale, Pa. (9) Duriron Co., Inc., Dayton, Ohio	Fe; 20–22 Cr; 10–12 Ni; 0.16 max. C	C	C
326	Stainless Type CG-16Se	Electric Steel Fdry. Co., Portland, Ore.	Fe; 20–22 Cr; 10–12 Ni; 0.16 max. C; 0.2-0.35 Se	C	C
327	Stainless Type CG-7C	Electro-Alloys Div., Amer. Brake Shoe Co., Elyria, Ohio	Fe; 20–22 Cr; 10–12 Ni; 0.07 max. C; 8xC-1 Cb	C	C
328	Stainless Type CG-7M	Empire Steel Castings, Inc., Reading, Pa.	Fe; 20–22 Cr; 10–12 Ni; 0.07 max. C; 1.5–3.5 Mo	C	C
329	Stainless Type CG-10M	General Alloys Co., Boston, Mass.	Fe; 20–22 Cr; 10–12 Ni; 0.1 max. C; 1.5–3.5 Mo	C	C
330	Stainless Type CG-16M	General Metals Corp., Oakland, Calif.	Fe; 20–22 Cr; 10–12 Ni; 0.16 max. C; 1.5–3.5 Mo	C	C
331	Stainless Type CG-7MC*	Grede Foundries, Milwaukee, Wis. Haynes Stellite Co., Kokomo, Ind. Hoskins Mfg. Co., Detroit, Mich.	Fe; 20–22 Cr; 10–12 Ni; 0.07 max. C; 1.5–3.5 Mo; 8xC-1 Cb	C	C
332	Stainless Type CH-10	Key Co., East St. Louis, Ill. Lebanon Steel Fdry., Lebanon, Pa.	Fe; 22–26 Cr; 12–15 Ni; 0.1 max. C	C	C
333	Stainless Type CH-20	Michiana Products Corp., Michigan City, Ind.	Fe; 22–26 Cr; 12–15 Ni; 0.2 max. C	C	C
334	Stainless Type CH-10C	Michigan Steel Casting Co., Detroit, Mich. Midvale Co., Philadelphia, Pa.	Fe; 22–26 Cr; 12–15 Ni; 0.1 max. C; 8xC-1 Cb	C	C
335	Stainless Type CH-10M	Milwaukee Steel Fdry., Milwaukee, Wis.	Fe; 22–26 Cr; 12–15 Ni; 0.1 max. C; 1.5–3.5 Mo	C	C
336	Stainless Type CH-20M*	National Alloy Div., Blaw-Knox Co., Blawknox, Pa.	Fe; 22–26 Cr; 12–15 Ni; 0.2 max. C; 1.5–3.5 Mo	C	C
337	Stainless Type CH-10MC*	Ohio Steel Fdry. Co., Cincinnati, Ohio Otis Elevator Co., Buffalo, N. Y.	Fe; 22–26 Cr; 12–15 Ni; 0.1 max. C; 1.5–3.5 Mo; 8xC-1 Cb	C	C
338	Stainless Type CK-25	Pacific Fdry. Co., Ltd., San Francisco, Calif.	Fe; 23–27 Cr; 19–22 Ni; 0.25 max. C	C	C
339	Stainless Type CM-25	Shawinigan Chemicals, Ltd., Montreal, Que. Sivyer Steel Casting Co., Milwaukee, Wis.	Fe; 8–11 Cr; 19–22 Ni; 0.25 max. C	C	C
340	Stainless Type CN-7	Standard Alloy Co., Cleveland, Ohio Sterling Alloys Inc., Woburn, Mass.	Fe; 18–22 Cr; 20–30 Ni; 0.07 max. C; may contain others	C	C
341	Stainless Type CN-25*	Symington-Gould Corp., Rochester, N. Y. (1) Taylor Wharton Iron & Steel Co., High Bridge, N. J.	Fe; 18–22 Cr; 20–30 Ni; 0.25 max. C; may contain others	C	C
342	Stainless Type CS-25*	Utility Electric Steel Fdry., Los Angeles, Calif.	Fe; 8–12 Cr; 29–32 Ni; 0.25 max. C	C	C
343	Stainless Type CT-7	Warman Steel Casting Co., Huntington Park, Calif.	Fe; 13–17 Cr; 34–37 Ni; 0.07 max. C; may contain others	C	C
344	Stainless Type CT-25*		Fe; 13–17 Cr; 34–37 Ni; 0.25 max. C; may contain others	C	C
345	Stainless Type HB		Fe; 18–22 Cr; 2 max. Ni	C	H
346	Stainless Type HC		Fe; 26–30 Cr; 4 max. Ni	C	H
347	Stainless Type HD		Fe; 26–30 Cr; 3–6 Ni	C	H
348	Stainless Type HE		Fe; 26–30 Cr; 8–11 Ni	C	H
349	Stainless Type HF		Fe; 18–23 Cr; 8–11 Ni	C	H
350	Stainless Type HH		Fe; 23–27 Cr; 11–14 Ni	C	H
351	Stainless Type HI		Fe; 26–30 Cr; 14–17 Ni	C	H
352	Stainless Type HK		Fe; 23–27 Cr; 19–22 Ni	C	H
353	Stainless Type HL		Fe; 28–32 Cr; 19–22 Ni	C	H

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Forms Available	Primarily for
354	Stainless Type HN		Fe; 18-22 Cr; 23-26 Ni	C	H
355	Stainless Type HP		Fe; 28-32 Cr; 29-31 Ni	C	H
356	Stainless Type HS		Fe; 8-12 Cr; 29-32 Ni	C	H
357	Stainless Type HT		Fe; 13-17 Cr; 33-37 Ni	C	H
358	Stainless Type HU		Fe; 17-21 Cr; 37-41 Ni	C	H
359	Stainless Type HW		Fe; 10-14 Cr; 58-62 Ni	C	H
360	Stainless Type HX		Fe; 15-19 Cr; 64-68 Ni	C	H
362	Still Metal	Amer. Manganese Bronze Co., Philadelphia, Pa.	Cu; Sn	C	C
363	Stoodite	Stoody Co., Whittier, Calif.	Fe; 33 Cr; 4.5 Mn; 2 Si; 4C	Welding rod	A
364	Stoody 1	Stoody Co., Whittier, Calif.	Co; 25 Cr; 13 W; 2 C	C, welding rod	C, H, A
365	Stoody 6	Stoody Co., Whittier, Calif.	Co; 25 Cr; 5.5 W; 1 C	C, welding rod	C, H, A
366	Stoody Self Hardening	Stoody Co., Whittier, Calif.	Fe; 6 Cr; 2.5 Mn; 1.5 Si; 1 C	Welding rod	A
367	Super Nickel	Amer. Brass Co., Waterbury, Conn.	70 Cu; 30 Ni	B, S, R, T, W, P	C
368	Tantalum	Fansteel Metallurgical Corp., North Chicago, Ill.	99.9+ Ta	B, CR, D, S, R, T, W	C
369	Telnic Bronze	Chase Brass and Copper Co., Waterbury, Conn.	98.3 Cu; 1 Ni; 0.2 P; 0.5 Te	R	C
370	Thermalloy Stainless	Electro Alloys Div., Amer. Brake Shoe Co., Elyria, Ohio	Various standard stainless steels; see Nos. 275-360	C	H
371	Timken Stainless	Steel and Tube Div., Timken Roller Bearing Co., Canton, Ohio	Various standard stainless steels; see Nos. 275-360	B, CR, HR, R, T, W	C, H
372	Tisco 150 Alloy	Taylor-Wharton Iron and Steel Co., Easton, Pa.	Fe; 2.5-3 C; 2 Si; 1-1.5 Ni; 28-32 Cr	C	A, C
373	Tisco Timang MnNi Steel	Taylor-Wharton Iron and Steel Co., Easton, Pa.	Fe; 0.6-0.8 C; 13-15 Mn; 3 Ni	P, R	A
374	Tisco Mn Steel	Taylor-Wharton Iron and Steel Co., Easton, Pa.	Fe; 12 Mn (Hadfield type)	C	A
375	Toncan Cu Mo Iron	Republic Steel Corp., Cleveland, Ohio		B, CR, HR, P, S	C
376	Tophet A	Wilbur B. Driver Co., Newark, N. J.	80 Ni; 20 Cr	D, HR, R, W	H
377	Tophet C	Wilbur B. Driver Co., Newark, N. J.	Fe; 60 Ni; 15 Cr	D, HR, R, W	H
378	Tophet D	Wilbur B. Driver Co., Newark, N. J.	Fe; 35 Ni; 18.5 Cr	B, CR, D, HR, R, W	H
379	Tube Borium	Stoody Co., Whittier, Calif.	60 tungsten carbide; 40 steel	Welding rod	A
380	Tuf-Stuf	Mueller Brass Co., Port Huron, Mich.	86.9 Cu; 10 Al; 3 Fe; 0.1 Mn	B, D, R, F	C, H, A
381	U. S. S. Stainless	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.	Various standard stainless steels; see Nos. 275-360	B, CR, HR, P, S, R, strip	C, H
382	U. S. S. Cor-Ten	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.	Fe; 0.12 max. C; 0.25-0.55 Cu; 0.5-1.25 Cr; 0.65 max. Ni	B, HR, P, S, R, strip	C, A
383	U. S. S. Man-Ten	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.	Fe; 0.25 max. C; 1.1-1.6 Mn; 0.2 min. Cu	B, HR, P, S, R, strip	C, A
384	U. S. S. A-R	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.	Fe; 0.35-0.5 C; 1.5-2 Mn; 0.15-0.3 Si	B, HR, P, S, strip	A
385	Utiloy Stainless	Utility Electric Steel Fdry., Los Angeles, Calif.	Various standard stainless steels; see Nos. 275-360	C	C, H
386	Vanadium Stainless	Vanadium Alloys Steel Co., Latrobe, Pa.	Various standard stainless steels; see Nos. 275-360	B, HR, D, P, R, W	C, H, A
387	Vanadium Stainless B	Vanadium Alloys Steel Co., Latrobe, Pa.	Fe; 14-18 Cr; 0.12 min. C	B, HR, D, P, R, W	C, A
388	Vanadium Stainless 79S	Vanadium Alloys Steel Co., Latrobe, Pa.	Fe; 14-18 Cr; 2 max. Ni; 0.15 min. C	B, HR, P, R, W	C, A
389	Vanadium Stainless U	Vanadium Alloys Steel Co., Latrobe, Pa.	Fe; 17-19 Cr; 7-9.5 Ni; 0.15 max. C; 1-1.5 Cu; 1-1.5 Mo	B, HR, P, R, W	C, H
390	Worthite	Worthington Pump and Machinery Corp., Harrison, N. J.	Fe; 20 Cr; 24 Ni; 0.07 max. C; 3.25 Si; 3 Mo; 1.75 Cu; 0.5 Mn	B, C, HR, R, W	C
391	Wrought Iron, Genuine	A. M. Byers Co., Pittsburgh, Pa.	Fe; 0.02 C; 0.03 Mn; 0.12 P; 0.15 Si; 0.02 S	B, HR, P, R, S, T	C
392	Wyndaloy	Wyndale Mfg. Corp., Indianapolis, Ind.	60 Cu; 20 Ni; 20 Mn	B, CR, HR, D, P, R, T, F	C, A

CARBON & GRAPHITE

No.	Material	Manufacturer	Description
400	International	International Graphite and Electrode Corp., St. Mary's, Pa.	Graphite. Electrodes and various shapes.
401	Karbate (Carbon)	National Carbon Co., Cleveland, Ohio	Impervious carbon.
402	Karbate (Graphite)	National Carbon Co., Cleveland, Ohio	Impervious graphite. Pipe, fittings, pumps, valves, towers and auxiliary parts, tanks, heat exchangers, brick, raschig rings, plates, rods, etc.
403	National Kempruf	National Carbon Co., Cleveland, Ohio	Carbon.
404	National Acheson	National Carbon Co., Cleveland, Ohio	Graphite.
405	Speer	Speer Carbon Co., St. Mary's, Pa.	Carbon and graphite. Brick, plates, blocks, tubes, cylinders, bushings, shapes.
406	Stackpole	Stackpole Carbon Co., St. Mary's, Pa.	Carbon and graphite. Tubes, pipe, rods, plates, bearings, seal rings, crucibles, heat treating boxes and molds.
			Impervious graphite. Pipe, bearings, seal rings, special shapes (injector body and nozzles.)

CEMENT, MORTAR, PUTTY

No.	Material	Manufacturer	Description
500	Sul. Cement	Generally available	Sulphur cement, silica aggregate, plasticized with Thiokol.
501	Sul. Cement	Generally available	Sulphur cement, carbon aggregate, plasticized with Thiokol.
502	Furan Cem.	Generally available	Furan derivative, silica aggregate, sets by chemical reaction.
503	Furan Cem.	Generally available	Furan derivative, carbon aggregate, sets by chemical reaction.
504	Phen. Cem.	Generally available	Phenol-formaldehyde, silica aggregate, sets by chemical reaction.
505	Phen. Cem.	Generally available	Phenol-formaldehyde, carbon aggregate, sets by chemical reaction.
506	Silicate Cem.	Generally available	Sodium silicate, silica aggregate, slow setting.
507	Silicate Cem.	Generally available	Sodium silicate, silica aggregate, sets by chemical reaction.
508	Acichlor	Pecora Paint Co., Philadelphia, Pa.	Firm putty.
509	Acidol	The Sullivan Co., Memphis, Tenn.	Pouring cements.
510	Acitite	Pecora Paint Co., Philadelphia, Pa.	Ready mixed cement; troweling.
511	Alkor	Atlas Mineral Products Co., Mertztown, Pa.	Furan derivative; carbon aggregate.
512	Alkor-S	Atlas Mineral Products Co., Mertztown, Pa.	Furan derivative; silica aggregate.
513	Asplit	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Chemical hardening resin cement.
514	Asplit F	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Chemical hardening resin cement.

NOTE: Nos. 500-507 are the eight standard types of cement, or mortar, that predominate in chemical construction. Each has been rated against 55 chemicals by C. R. Payne, vice president and technical director of Atlas Mineral Products Co., who, rather than speak only for his own company's products, has consented to provide this comprehensive treatment of cements according to type. His ratings are on the conservative side.

No.	Material	Manufacturer	Description
515	**Basolit**	Nukem Products Corp., Buffalo, N. Y.	Sulphur-silicate cement.
516	**Carbo Korez**	Atlas Mineral Products Co., Mertztown, Pa.	Phenol-formaldehyde; carbon aggregate.
517	**Carboline**	Carboline Co., St. Louis, Mo.	Carbonaceous resin cement.
518	**Carbon Basolit**	Nukem Products Corp., Buffalo, N. Y.	Sulphur-carbon cement.
519	**Carbo Vitrobond**	Atlas Mineral Products Co., Mertztown, Pa.	Sulphur cement; carbon aggregate.
520	**Carolina**	Charlotte Chemical Laboratories, Charlotte, N. C.	Acid proof cement.
521	**Causplit**	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Chemical hardening resin cement.
522	**Charlab**	Charlotte Chemical Laboratories, Charlotte, N. C.	Chemical putty.
523	**Duralon**	U. S. Stoneware Co., Akron, Ohio	Furan base resin cements.
524	**Durasite**	U. S. Stoneware Co., Akron, Ohio	Furan base resin cements.
525	**Fairprene**	E. I. du Pont de Nemours & Co., Wilmington, Del.	Synthetic elastomer cement.
526	**Filtros**	Filtros, Inc., East Rochester, N. Y.	Acid proof cement.
527	**Haveg 41-G**	Haveg Corp., Newark, Del.	Quick setting, phenolic resin grouting cement.
528	**Haveg 41-R**	Haveg Corp., Newark, Del.	Quick setting phenolic resin cement for Haveg 41.
529	**Haveg 43-HF**	Haveg Corp., Newark, Del.	Quick setting phenolic resin cement for Haveg 43.
530	**Haveg 60-R**	Haveg Corp., Newark, Del.	Quick setting furane resin cement for Haveg 60.
531	**Korez**	Atlas Mineral Products Co., Mertztown, Pa.	Phenol-formaldehyde; silica aggregate.
532	**Lumnite**	Lumnite Div., Universal Atlas Cement Co., New York	Hydraulic cement; powder for mixing with aggregate and water to make concrete.
533	**N-380 Silicate**	Philadelphia Quartz Co., Philadelphia, Pa.	Sodium silicate; to be combined with special proprietary quick-setting cements at time of use.
534	**N-Series**	Union Bay State Chemical Co., Cambridge, Mass.	Neoprene base cements to be used as lining for tanks, etc.
535	**Nukem All-Purpose**	Nukem Products Corp., Buffalo, N. Y.	Resinous cement.
536	**Nukem Silicate**	Nukem Products Corp., Buffalo, N. Y.	Silicate cement.
537	**Pecomastic**	Pecora Paint Co., Philadelphia, Pa.	Putty; troweling; brushing.
538	**Penchlor Acid-Proof**	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Quick setting silicate cement.
539	**Penchlor Acid-Proof S25**	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Quick setting silicate cement.
540	**Penchlor Fire-Proof**	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Quick setting silicate cement.
541	**Pennsalt PRF**	Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Chemical hardening resin cement.
542	**Permanite**	Maurice A. Knight, Akron, Ohio	Furane base resin cement.
543	**Plastikon**	B. F. Goodrich Rubber Co., Akron, Ohio	Rubber-base putty.
544	**Plastite**	U. S. Stoneware Co., Akron, Ohio	Calking putty.
545	**Plasul Basolit**	Nukem Products Corp., Buffalo, N. Y.	Plasticized sulphur-silicate cement.
546	**Porox**	Patterson Fdry. & Machine Co., East Liverpool, Ohio	Silicate cement.
547	**Quigley**	Quigley Co., New York, N. Y.	Acidproof cements.
548	**Reardon**	Reardon Industries, Cincinnati, Ohio	Acidproof cement.
549	**Redux**	Resinous Products & Chemicals Co., Philadelphia, Pa.	Metal-to-metal resin adhesive.
550	**Sauereisen 31**	Sauereisen Cements Co., Pittsburgh, Pa.	Acidproof cement.
551	**Sauereisen 44**	Sauereisen Cements Co., Pittsburgh, Pa.	Plastic; acid tank sealer.
552	**Sauereisen 48**	Sauereisen Cements Co., Pittsburgh, Pa.	Joint compound.
553	**Silicate**	Philadelphia Quartz Co., Philadelphia, Pa.	Sodium silicate; to be used with silica for acid resistant cements.
554	**Silastic 121**	Dow Corning Corp., Midland, Mich.	Silicone elastomers in putty form for calking.
555	**Stackpole**	Stackpole Carbon Co., St. Mary's, Pa.	Carbonaceous cements for carbon, graphite, and carbon-to-metal joints.
556	**Staminite**	Robinson Clay Product Co., Akron, Ohio	Acidproof cement.
557	**Sulsilo**	The Sullivan Co., Memphis, Tenn.	Pre-mixed silicate cement.
558	**Tegul Vitrobond**	Atlas Mineral Products Co., Mertztown, Pa.	Sulphur cement; silica aggregate.
559	**Thiokol**	Thiokol Corp., Trenton, N. J.	Liquid (100% solids) rubber polymers.
560	**Vitrex**	Atlas Mineral Products Co., Mertztown, Pa.	Sodium silicate; sets by chemical reaction.

CERAMICS

No.	Material	Manufacturer	Description
600	**Acidproof Brick**	Generally available *	Brick, stone, tile, rings, plates, cylinders, tower packing, tower linings, etc.
601	**Alsop Glass Lining**	Alsop Engineering Co., Milldale, Conn.	Glass-lined tanks, mixers and filters.
602	**Amersil Fused Silica**	Amersil Co., Inc., Hillside, N. J.	Fused silica ware. Pans, pipes, gas coolers, absorbers insulators tubes plates.
603	**Carrara**	Pittsburgh Plate Glass Co., Pittsburgh, Pa.	Structural glass, flat or bent.
604	**Coratherm**	U. S. Stoneware Co., Akron, Ohio	Ceramic ware. Process equipment.
605	**Fiberglas**	Owens-Corning Fiberglas Corp., Toledo, Ohio	Fibrous glass cloth and mat. Air filters, thermal insulation, tower packing, filter cloth.
606	**"General" Chemical Stoneware**	General Ceramics & Steatite Corp., Keasbey, N. J.	Chemical stoneware. Tanks, kettles, pipe, fittings, valves, pumps, coils, filters, etc.
607	**Glascote Glass Lining**	Glascote Products, Inc., Cleveland, Ohio	Glass lined tanks and processing equipment.
608	**Hanovia Fused Quartz**	Hanovia Chemical & Mfg. Co., Newark, N. J.	Transparent fused quartz in all shapes.
609	**Illinois Chemical Porcelain**	Illinois Electric Porcelain Co., Macomb, Ill.	Ceramic chemical porcelain. Pipes, valves, fittings.
610	**Knight-Ware**	Maurice A. Knight, Akron, Ohio	Chemical stoneware. Tanks, kettles, pipe, fittings, valves, pumps, coils, filters, etc.
611	**Lapp Porcelain**	Lapp Insulator Co., Le Roy, N. Y.	Chemical porcelain. Pipe, fittings, valves, plug cocks, towers, tower packing, special shapes.
612	**Pennvernon**	Pittsburgh Plate Glass Co., Pittsburgh, Pa.	Window glass, flat.
613	**Permaglas**	A. O. Smith Corp., Milwaukee, Wis.	Glass lined steel equipment.
614	**Pfaudler Glass Lining**	The Pfaudler Co., Rochester, N. Y.	Glass-lined steel equipment.
615	**Pittsburgh Plate Glass**	Pittsburgh Plate Glass Co., Pittsburgh, Pa.	Polished plate glass, flat or bent.
616	**Pyrex**	Corning Glass Works, Corning, N. Y.	Glass. Pipe, fittings, sight glasses, gage glasses, heat resistant plate.
617	**"U. S." Chemical Stoneware**	U. S. Stoneware Co., Akron, Ohio	Chemical stoneware. Tanks, kettles, pipe, fittings, valves, pumps, coils, filters, etc.

* Acidproof brick and stone products are available from the following (tradenames, where they differ from name of company, are in parentheses): Acme Brick Co., Fort Worth, Tex (Acitex, Everlast, La Perla); Alabama Clay Products Co., Birmingham, Ala; Alberene Stone Corp. of Va., New York, N. Y.; Atlas Mineral Products Co., Mertztown, Pa.; Belden Brick Co., Canton, Ohio; Charlotte Chemical Labs., Charlotte, N. C. (Carolina); Claycraft Co., Columbus, Ohio; Custodis Construction Co., New York, N. Y. (Aco); Electro-Chemical Supply & Engineering Co., Paoli, Pa.; Filtros Inc., East Rochester, N. Y.; General Refractories Co., Philadelphia, Pa. (Acido); Harbinson-Walker Refractories Co., Pittsburgh, Pa.; B. Mifflin Hood Co., Daisy, Tenn.; Keagler Brick Co., Steubenville, Ohio; Kewaunee Mfg. Co., Kewaunee, Wis. (Karcite, Kemrock); Metropolitan Paving Brick Co., Canton, Ohio; Parker-Russell Mining & Mfg. Co., St. Louis, Mo.; Patterson Fdry. & Machine Co., East Liverpool, Ohio; Quigley Co., New York, N. Y.; Robinson Clay Product Co., Akron, Ohio; Southern Clay Mfg. Co., Chattanooga, Tenn.; Thornton Firebrick Co., Clarksburg, W. Va.

No.	Material	Manufacturer	Description
618	Vitreo	Vitreous Steel Products Co., Cleveland, Ohio	Acid resisting porcelain enameled steel. Drying and evaporating trays, miscellaneous parts.
619	Vitreosil	The Thermal Syndicate Ltd., New York, N. Y.	Vitreous silica. Pipes, tubes, rods, plates, dishes, retorts, stills, HCl acid plant, and apparatus for absorption, cooling, and condensing.
620	Vitreous Enamel	Vitreous Enameling & Stamping Co., New York, N. Y.	Enameled tanks and specialties.
621	Vycor	Corning Glass Works, Corning, N. Y.	96% Silica glass. Tubing, rods, flat ware, various shapes.

PLASTICS

No.	Material	Manufacturer	Description
700	Ace Saran	Amer. Hard Rubber Co., New York, N. Y.	Vinylidene chloride. Pipe, fittings, tubing.
701	Celcon	Celanese Plastics Corp., New York, N. Y.	Ethyl cellulose.
702	Celluloid	Celanese Plastics Corp., New York, N. Y.	Cellulose nitrate.
703	Compar	Resistoflex Corp., Belleville, N. J.	Solution of compounded polyvinyl alcohol. Solution for dipping or painting.
704	DC 801-804	Dow Corning Corp., Midland, Mich.	Solvent dispersed silicone resins for coatings.
706	Formica CHN-5	Formica Insulation Co., Cincinnati, Ohio	Reinforced phenol-formaldehyde. Sheet, tube, rod.
707	Formica CN-22	Formica Insulation Co., Cincinnati, Ohio	Reinforced phenol-formaldehyde. Sheet and rod.
708	Formica LN-41	Formica Insulation Co., Cincinnati, Ohio	Reinforced melamine. Sheet, tube, rod.
709	Forticel	Celanese Plastics Corp., New York, N. Y.	Cellulose propionate.
710	Geon	B. F. Goodrich Chemical Co., Cleveland, Ohio	Polyvinyl chloride plastics.
711	Haveg 41	Haveg Corp., Newark, Del.	Phenolic-asbestos plastic. Pipe, pumps, tanks, blowers, agitators, valves, towers coolers, fume duct, hoods.
712	Haveg 43	Haveg Corp., Newark, Del.	Furane-asbestos plastic.
713	Haveg 60	Haveg Corp., Newark, Del.	Phenolic-graphite plastic.
714	Haveg 63	Haveg Corp., Newark, Del.	Furane-graphite plastic.
715	Heresite M66	Heresite and Chemical Co., Manitowoc, Wis.	Transparent molding powder.
716	Heresite MF 68	Heresite and Chemical Co., Manitowoc, Wis.	Black molding powder.
717	Insurok	Richardson Co., Melrose Park, Ill.	Molded and laminated plastics. Sheet, rod, tube, fabricated parts, special moldings.
718	Koroseal	B. F. Goodrich Co., Akron, Ohio	Plasticised polyvinyl chloride. Sheet lining for tanks and fume ducts.
719	Kriston	B. F. Goodrich Chemical Co., Cleveland, Ohio	Allyl ester thermosetting materials.
720	Lamicoid	Mica Insulator Co., Schenectady, N. Y.	Phenolic laminate, fabric base. Sheets.
721	Lumarith	Celanese Plastics Corp., New York, N. Y.	Cellulose acetate.
722	Micarta	Westinghouse Electric Corp., Pittsburgh, Pa.	Laminated plastics, fabric or kraft base. Sheets, chanels, angles, molded shapes.
723	Nixon CA (Nixonite)	Nixon Nitration Works, Nixon, N. J.	Cellulose acetate. Sheets, rods, molding powders.
724	Nixon CN (Nixonoid)	Nixon Nitration Works, Nixon, N. J.	Cellulose nitrate. Sheets, rods, tubes.
725	Nixon EC	Nixon Nitration Works, Nixon, N. J.	Ethyl cellulose. Molding powders.
726	Nukemite	Nukem Products Corp., Buffalo, N. Y.	Synthetic resin sheet and coating.
727	Nylon FM-1	E. I. du Pont de Nemours & Co., Wilmington, Del.	Injection moldings. Heat resistant injection molded parts.
728	Nylon FM-3	E. I. du Pont de Nemours & Co., Wilmington, Del.	Injection and extrusion moldings. Wire covering.
729	Nylon FM-4	E. I. du Pont de Nemours & Co., Wilmington, Del.	Injection, compression, and extrusion moldings.
730	Nylon FM-100	E. I. du Pont de Nemours & Co., Wilmington, Del.	Injection and extrusion moldings.
731	Nylon FM-101	E. I. du Pont de Nemours & Co., Wilmington, Del.	Injection, compression, and extrusion moldings. Tubing, sheeting, wire covering, gasketing.
732	Nylon FM-102	E. I. du Pont de Nemours & Co., Wilmington, Del.	Injection and extrusion moldings. Wire covering.
733	Permanite	Maurice A. Knight, Akron, Ohio	Furane base resin. Laminates, fabricated shapes.
734	Phenolite	National Vulcanised Fibre Co., Wilmington, Del.	Laminated phenolics. Sheet, tube, rod.
735	Polythene	E. I. du Pont de Nemours & Co., Wilmington, Del.	Polyethylene. Sheet, rod, tube, molding powders, film, filament. Pipe, pipe lining, gaskets, etc.
736	Pyroflex Construction	Maurice A. Knight, Akron, Ohio	Thermoplastic resin lining plus steel, brick, etc. to make a functional unit.
737	Resilon	U. S. Stoneware Co., Akron, Ohio	Bituminous linings and membranes.
738	Resistoflex	Resistoflex Corp., Belleville, N. J.	Compounded polyvinyl alcohol extruded tubing. Fiber or wire braided hose.
739	Resistoflex Compar	Resistoflex Corp., Belleville, N. J.	Compounded polyvinyl alcohol molded. Molded shapes; abrasion resistant gaskets, pump diaphragms, sand blasting mats, rollers, etc.
740	Saran	Dow Chemical Company, Midland, Mich.	Vinyl chloride-vinylidene chloride copolymer. Pipe, pipe fittings, tube, tube fittings.
741	Sealon	Maurice A. Knight, Akron, Ohio	Polyvinyl chloride elastomer. Tank linings, sheets, gaskets.
742	Teflon	E. I. du Pont de Nemours & Co., Wilmington, Del.	Polymerized tetrafluoroethylene. Rods, tubes, sheets, beading, gaskets, thin tapes.
743	Textolite 1422	General Electric Co., Pittsfield, Mass.	Rods and plates.
744	Textolite 2001	General Electric Co., Pittsfield, Mass.	Graphited phenolic laminate. Sheet, rod, tube.
745	Textolite 2013	General Electric Co., Pittsfield, Mass.	Fabric base, phenolic laminate. Sheet, rod, tube.
746	Tygon	U. S. Stoneware Co., Akron, Ohio	Synthetic compounds. Linings, tubing, protective coatings, etc.
747	Vimlite	Celanese Plastics Corp., New York, N. Y.	Mesh reinforced plastic.
748	Vulcanized Fibre	National Vulcanised Fibre Co., Wilmington, Del.	Sheets, tubes, rod.
749	Zerok	Atlas Mineral Products Co., Mertztown, Pa.	Polyvinyl chloride. Tank linings and coatings.

RUBBER

No.	Material	Manufacturer	Description
800	Ace Hard Rubber	Amer. Hard Rubber Co., New York, N. Y.	Vulcanized rubber. Rod, sheet, tube, molded parts, linings, pipe, fittings, etc.
801	Acidseal E	B. F. Goodrich Co., Akron, Ohio	Hard rubber. Sheet lining for tanks and miscel. metal parts.*
802	Acidseal MA and PA	B. F. Goodrich Co., Akron, Ohio	Soft rubber. Sheet lining for tanks and miscel. metal parts.*
803	Armstrong	Armstrong Cork Co., Lancaster, Pa.	Gaskets.
804	Boston	Boston Woven Hose & Rubber Co., Boston, Mass.	Conveyor and transmission belt, hose, mechanical goods.
805	Butyl (GR-I)	Stanco Distributors, Inc., New York, N. Y.	Solid copolymer of isobutylene and isoprene.
806	Crane	Crane Packing Co., Chicago, Ill.	Packing and mechanical seals.
807	Custoplast	Custodis Construction Co., New York, N. Y.	Soft rubber and neoprene tank linings.
808	Dayton	Dayton Rubber Mfg. Co., Dayton, Ohio	Oilproof rubber belt, transmission belt.
809	Fairprene	E. I. du Pont de Nemours & Co., Wilmington, Del.	Sheet and coated fabric made from vulcanized neoprene. Linings, diaphragms, gaskets, packing.

No.	Material	Manufacturer	Description
810	**Firestone**	Firestone Tire & Rubber Co., Akron, Ohio	Vibration dampeners, adhesives, sheet, tape, hose, belting, fabric, moldings, extrusions.
812	**Garlock**	Garlock Packing Co., Palmyra, N. Y.	Gaskets, packings, moldings, Klosure oil seals.
813	**Gates**	Gates Rubber Co., Denver, Colo.	Belts, hose, moldings.
814	**G. E. Silicone Rubber**	General Electric Co., Pittsfield, Mass.	Sheets, extruded shapes, molded parts, coating pastes.
816	**Greene-Tweed**	Greene, Tweed & Co., New York, N. Y.	Packing, gaskets, sheet.
817	**Heresite Rubber**	Heresite & Chemical Co., Manitowoc, Wis.	Synthetic rubber coatings.
818	**Hewitt**	Hewitt Rubber Corp., Buffalo, N. Y.	Hose, belting, packing, moldings, extrusions.
820	**Hycar (GR-A)**	B. F. Goodrich Chemical Co., Cleveland, Ohio	Nitrile type synthetic rubber.
821	**Jenkins**	Jenkins Bros. Rubber Div., Bridgeport, Conn.	Mechanical goods, packing, valve discs, tape, moldings, extrusions.
822	**Johns Manville**	Johns-Manville Sales Corp., New York, N. Y.	Gaskets.
825	**Linear**	Linear Packing & Rubber Co., Philadelphia, Pa.	Packing.
826	**Luzerne**	Luzerne Rubber Co., Trenton, N. J.	Hard rubber pipe, fittings, valves, shapes, tanks, rayon equipment.
827	**Manhattan**	Manhattan Rubber Mfg. Div., Passaic, N. J.	Belting, blocks, hose, pipe, rolls.
828	**Neobon**	Atlas Mineral Products Co., Mertztown, Pa.	Neoprene-base lining for tanks, fans, fume ducts, etc.
829	**Neoprene**	E. I. du Pont de Nemours & Co., Wilmington, Del.	Polymer of chloroprene. Crude neoprene for compounding and curing.
830	**Parakote**	Paramount Rubber Co., Detroit, Mich.	Plating rack insulation for racks to be coated at Paramount plant.
831	**Paramount**	Paramount Rubber Co., Detroit, Mich.	Neoprene, buna-S, natural rubber. Sheets for tank lining.
834	**Parlon**	Hercules Powder Co., Wilmington, Del.	Chlorinated rubbers. Used as a base for concrete paints.
835	**Perbunan (GR-A)**	Stanco Distributors, Inc., New York, N. Y.	Copolymer of butadiene and acrylonitrile. Solid sheets.
836	**Permobond Natural (soft)**	U. S. Rubber Co., New York, N. Y.	
837	**Permobond Natural (hard)**	U. S. Rubber Co., New York, N. Y.	
838	**Permobond GR-S (soft)**	U. S. Rubber Co., New York, N. Y.	
839	**Permobond GR-S (hard)**	U. S. Rubber Co., New York, N. Y.	
840	**Permobond GR-A (soft)**	U. S. Rubber Co., New York, N. Y.	Linings for tanks, pipes, fittings, valves.
841	**Permobond GR-A (hard)**	U. S. Rubber Co., New York, N. Y.	
842	**Permobond GR-M (soft)**	U. S. Rubber Co., New York, N. Y.	
843	**Permobond GR-P (soft)**	U. S. Rubber Co., New York, N. Y.	
844	**Permobond GR-I**	U. S. Rubber Co., New York, N. Y.	
845	**Plioweld**	Goodyear Tire & Rubber Co., Akron, Ohio	Rubber-lined tanks, pipe, etc.*
846	**Saniprene**	B. F. Goodrich Co., Akron, Ohio	Hard rubber. Sheet lining for tanks and miscel. metal parts.*
847	**Self Vulcanizing**	Self Vulcanizing Rubber Co., Chicago, Ill.	Linings and coatings.
848	**Silastic 181**	Dow Corning Corp., Midland, Mich.	Silicone rubber in form of crepes for molding and extruding.
849	**Superflexite**	B. F. Goodrich Co., Akron, Ohio	Hard rubber. Sheet lining for tanks and miscel. metal parts.*
850	**Stokes**	Jos. Stokes Rubber Co., Trenton, N. J.	Hard rubber pipes, valves, fittings, miscel. moldings and extrusions.
851	**Tensilgrip**	Amer. Wringer Co., Woonsocket, R. I.	Natural and synthetic rubber lined tanks, pipe, pumps, ducts, etc.
852	**Thermoid**	Thermoid Rubber Div., Trenton, N. J.	Belting, hose, packing.
853	**Thiokol (GR-P)**	Thiokol Corp., Trenton, N. J.	Solid form.
854	**Thiokol**	Thiokol Corp., Trenton, N. J.	Water dispersions for linings.
855	**Triflex**	B. F. Goodrich Co., Akron, Ohio	Hard rubber layer sandwiched between two soft rubber layers. Sheet lining for tanks and miscel. metal parts.*
856	**Vistanex**	Stanco Distributors, Inc., New York, N. Y.	Polymerized isobutylene. Viscous liquid to solid, depending on mol. wt.
857	**Vulcanized**	Vulcanized Rubber Co., New York, N. Y.	Hard and semi-hard moldings.

* In addition to the lining material named, this company produces most of the following: hose, belt, packing, gaskets, moldings, extrusions, vibration dampeners, rubber-metal bonded products, hard rubber pipe and fittings.

WOOD

900 **Eastern red cedar**
901 **Port Orford cedar**
902 **Western red cedar**
903 **White cedar**
904 **Southern tidewater cypress**
905 **Douglas fir (Coast type)**
906 **Hard maple**
907 **White oak**
908 **Southern long-leaf pine**
909 **Southern short-leaf pine**
910 **Northern white pine**
911 **Red pine**
912 **Yellow poplar**
913 **California redwood**
914 **Spruce**

Following is a list of producers of wooden tanks, towers, pipe, and culverts. Companies in italic are members of the National Wood Tank Institute, Chicago, whose executive director, S. E. Chaney, provided all data on wood's resistance to chemicals.

ALABAMA: Hightower Box & Tank Co., Birmingham. ARKANSAS: Fordyce-Crossett Sales Co., Fordyce; Leird Lumber Co., Little Rock; Smith Fabricating Shop, Hot Springs. CALIFORNIA: Acme Tank Mfg. Co., Los Angeles; C. F. Braun Co., Los Angeles; Fluor Corp., Los Angeles; *W. D. Hall Co., El Cajon;* Hammond Lumber Co., San Francisco; *Industrial Manufacturers Ltd., Los Angeles;* Inman Tank, Pipe & Crossarm Co., San Leandro; *Pacific Tank & Pipe Co., Oakland;* Pacific Wood Tank Corp., San Francisco; Pope & Talbot Inc., San Francisco; Redwood Manufacturers Co., San Francisco; San Mateo Planing Mill, San Mateo; Union Lumber Co., San Francisco; *George Windeler Co., San Francisco.* COLORADO: Plattner Co., Denver; Stearns-Roger Mfg. Co., Denver. CONNECTICUT: G. H. Manville Pattern & Model Co., Waterbury. FLORIDA: G. M. Davis & Sons, Palatka; Timber Fabrications, Miami. GEORGIA: McCarr-Turner Co. ILLINOIS: *Batavia Metal Products Co., Batavia;* Benson Cooling Tower Co., Chicago; Binks Mfg. Co., Chicago; California Redwood Distributors, Chicago; *U. S. Challenge Co., Batavia;* Chicago Wooden Tank Co., Chicago; J. P. Devine Mfg. Co., Mt. Vernon; Eagle Tank Co., Chicago; *Johnson & Carlson, Chicago;* C. Jacobson & Co., Chicago; Lord & Bushnell Lumber Co., Chicago; McKeown Bros. Co., Chicago; E. W. Schmeling & Sons, Chicago; Technical Plywoods, Chicago; *Wendnagel & Co., Chicago;* Whyte-Coleman Co., Chicago. IOWA: Beckman Bros., Des Moines; *Dultmeter Tank Co., Manning;* Iowa Wind Mill & Pump Co., Cedar Rapids; Kretchmer Mfg. Co., Council Bluffs; Storm Lake Tank & Silo Co., Storm Lake; Wheeler Lumber, Bridge & Supply Co., Des Moines. KANSAS: Perdue Tank Co., Wichita; J. F. Pritchard & Co., Kansas City; Scherer Mfg. Co., Kansas City; Souder Tank Co., Madison; Stevens Tank Co., Wichita. KENTUCKY: *W. E. Caldwell Co., Louisville.* LOUISIANA: Lincoln Tank Co., Shreveport; McGuffin Tank Co., Shreveport; Moran Tank Co., Shreveport. MAINE: Stevens Tank & Tower Co., Auburn. MARYLAND: *Baltimore Cooperage Tank & Tower Co., Baltimore;* Economy Silo & Mfg. Co., Frederick; John Eppler Co., Baltimore; Maryland Engineering Co., Pikesville. MASSACHUSETTS: Rodney Hunt Machine Co., Orange; James Hunter Machine Co., North Adams; E. D. Jones & Sons Co., Pittsfield; New England Tank & Tower Co., Everett; Plymold Corp., Lawrence; Riggs & Lombard Inc., Lowell; J. C. Roy Lumber Co., Chicopee; *A. T. Stearns Lumber Co., Boston.* MICHIGAN: Kalamazoo Tank & Silo Co., Kalamazoo; Michigan Pipe Co., Bay City. MINNESOTA: Midway Lumber Co., St. Paul; Terminal Mfg. Co., St. Paul; Twin City Tank, Silo, & Specialty Co., Minneapolis. MISSOURI: Lillie-Hoffman Cooling Towers Inc., St. Louis; Schubert-Christy Corp., Afton; Water Cooling Equipment Corp., St. Louis. NEBRASKA: Nebraska Bridge Supply & Lumber Co., Omaha. NEW HAMPSHIRE: Improved Paper Machinery Corp., Nashua; Nashua Milling Corp., Nashua. NEW JERSEY: Acme Tank Co., Jersey City; *Atlantic Tank Corp., North Bergen;* A. J. Corcoran Inc., Jersey City; *General Tank Works Inc., Kearney;* Hanson-Van Winkle-Munning Co., Matawan. NEW YORK: *Arrow Tank Co., Buffalo;* M. C. Bascom & Co., Bolivar; Carley Heater Co., Olean; J. Holland & Sons, Brooklyn; Howard Wood Tank Co., Brooklyn; F. E. Hudson & Sons, Buffalo; Hydro & Chemical Tank Co., New York; David Isseks & Sons, Brooklyn; *O. G. Kelley & Co., New York; Mayer Tank Mfg. Co., Brooklyn;* Market Mfg. Co., Syracuse; Noble & Wood Machine Co., Hoosick Falls; Peerless Tank & Tower Co., New York; Phillips Cooling Tower Co., New York; Sandy Hill Iron & Brass Works, Hudson Falls; U. S. Plywood Corp., New York; Wenneis Tank Co., New York; *Wilcox-Johnson Tank Co., Victor;* A. Wyckoff & Son Co., Elmira. OHIO: Black-Clawson Co., Hamilton; Brown Lumber Co., Massilon; *Hauser-Stander Tank Co., Cincinnati;* Harvey Loehr Lumber Co., Canton; Shartle Bros. Machine Co., Middleton. OKLAHOMA: Black, Sivalls & Bryson Inc., Oklahoma City; National Tank Co., Tulsa; Parkersburg Rig & Reel Co., Tulsa; Producers Tank Co., Seminole. OREGON: Beall Pipe & Tank Corp., Portland; Cottage Grove Lumber Co., Cottage Grove; National Pipe & Tank Co., Portland. PENNSYLVANIA: Downingtown Mfg. Co., Downingtown; Eastern Wood Products Co., Williamsport; Everett Forest Products Co., Everett; Amos H. Hall & Sons, Philadelphia; H. K. Porter Co., Pittsburgh; E. F. Schlichter Co., Philadelphia; C. H. Wheeler Mfg. Co., Philadelphia; Woolford Wood Tanks, Darby. TENNESSEE: *O. G. Kelley & Co., Johnson City;* James E. Stark Co., Memphis. TEXAS: Axtell Co., Fort Worth; Cowser & Co., Dallas; Drane Tank Co., Fort Worth; Federal Tank Co., Midland; Hayward Tank Co., Greggton; Hudson Engineering Corp., Houston; Martin Tank Co., Corsicana; M & V Tank Co., Wichita Falls; *Alexander Schroeder Hardwood Lumber Co., Houston;* Tex Well Equipment Mfg. Co., Fort Worth; Well Machinery & Supply Co., Fort Worth; Wilborne Bros. Co., Amarillo. WASHINGTON: American Wood Pipe Co., Tacoma; Brooks Lumber Co., Bellingham; Brooks Tank Co., Everett; Cascade Pipe & Flume Co., Seattle; Federal Pipe & Tank Co., Seattle; Horizontal Stave Tank Co., Seattle; Robinson Wood Tank Co., Bellingham; Weyerhaeuser Sales Co., Tacoma; Whatcom Falls Mill Co., Bellingham. W. VIRGINIA: Parkersburg Rig & Reel Co., Parkersburg. WISCONSIN: Beloit Iron Works, Beloit; *Dunck Tank Works, Milwaukee;* Frank Hamechek Machine Co., Kewannee; Nekoosa Foundry & Machine Works, Nekoosa; Charles H. Stehling Co., Milwaukee; Stoelting Mfg. Co., Kiel.

CHEMICAL RESISTANCE

Of Constructional Metals and Non-Metals

From data supplied by the manufacturers the editors of *Chemical Engineering* have compiled this table showing the resistance of materials to 24 common and troublesome chemicals. Also shown are some of the important applications in which the materials are being used. Now a word of caution. Corrosion involves many more variables than this or any table can possibly recognize. These data should never be construed as anything more than an aid in narrowing the field of materials that are worth investigation.

NO. MATERIAL	RATINGS	EXPOSURE CONDITIONS	APPLICATIONS
Significance of Nos.: 1–3xx Metals 4xx Carbon 5xx Cement 6xx Ceramics 7xx Plastics 8xx Rubber 9xx Wood To further identify material look up No. in Directory of Materials	Ratings are those of materials manufacturers. A, good F, fair V, varies depending on conditions X, unsuitable	° = Deg. F. % = Concentration Rm. = Room temp. Conc. = Concentrated Dil. = Dilute Sol. = Solution p.s.i. = lb./sq. in. —L = Lined	B, Bodies of pumps and valves I, Impellers V, Valve trim P, Piping T, Tanks S, Shipping containers C, Condensing surfaces H, Heating surfaces D, Ducts for fumes F, Fans and blowers R, Tower packing

ACETIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	**Admiralty**	A		
4	**Admiralty**	V		CH
6	**Adnic**	A	All %; 70–212°	
10–17	**Aluminum**	A	All %; Rm.	BIPTSDF
		A	Glacial; 212°	BIPTSCHDF
19	**Alloyco**	A	All to 100%; boil.	BV
		A	Vapors; 30, 100%; hot	BV
22	**Ambralloy**	F		CH
23	**Ambralloy**	F		CH
24	**Ambralloy**	V		CH
29–40	**Ampco**	A	All %; cold; crude or pure	BIVPTCHDF
		V	Vapors	
51	**Berylco**	A	Non-aerated	
54	**Brass**	X		
61	**Brass**	X		
63	**Brass**	A-F		PCH
66	**Bronze**	A		
73	**Bronze**	F		VT
74	**Bronze**	F		V
75	**Bronze**	F		VP
76	**Bronze**	F		Instruments
77	**Bronze**	X		
81	**CA-FA20**	A	Glacial; boil.	BIVP
82	**CA-MM**	A	Glacial; boil.	BIVP
86	**Cast Iron**	V	Crude	
87	**Causul**	F	180° max.	B
88	**Chlorimet**	A	All %; any temp.	BIVCHF
89	**Chlorimet**	A	All %; any temp.	BIVCHF
111	**Copper**	A		
114	**Copper**	F		PTCHR
117	**Copper**	V		S
118	**Copper**	A		
119	**Corrosiron**	A	All %; Rm.	BIPHDF
123	**Cupro-Ni**	F		CH
124	**Cupro-Ni**	A		
139	**Durco**	A	All %; any temp.	BIVHF
140	**Durichlor**	A	All %; any temp.	BIVPCHFR
141	**Durimet**	A	All %; any temp.	BIVHF
142	**Durimet**	A	All %; any temp.	BIVHF
143	**Duriron**	A	All %; any temp.	BIVPHFR
148	**Everdur**	F		BIVFR
149	**Everdur**	F		PTCHDR
150	**Everdur**	F		PCH
156	**Gold**	A	0.5–100%; any temp.	
159	**Hastelloy**	A	All %; any temp.	BIVPTCH
160	**Hastelloy**	A	All %; any temp.	BIVPTCHDF
161	**Hastelloy**	A	All %; any temp.	BIVPTCHDF
162	**Hastelloy**	A	All %; any temp.	BIVP
163	**Stellite**	A	All %; any temp.	BIV
165	**Stellite**	A	All %; any temp.	BIV
184	**Inconel**	A	5%; aerated; 86°	
		F	5, 50%; unaerated; boil.	C
		F	80%; storage	
		A	Glacial; boil.	C
196, 200, 266	**Lead**	V	Conc. or glacial; unaerated	PT
216	**Monel**	X	5%; aerated; 86°	
		A	5, 50%; unaerated; boil.	BIVPTCH
		A	80%, storage	
		A	Glacial; boil.	
219	**Muntz**	X		
224	**Nickel**	X	5%; aerated; 86°	
		F	5, 50%; unaerated; boil.	BVPTH
		F	80%; storage	
		A	Glacial; boil.	
225	**Ni-Clad**	A		BTSC
226	**Nick-Sil.**	F		Instruments
231	**Ni-Resist**	X	5%; aerated; 86°	
		X	5%, 50%; unaerated; boil.	
233	**NS-5**	A	Dil.; impure; 150° max.	V
234	**Olympic**	A		
235	**Olympic**	A		
236	**Palladium**	A	0.5–100%; any temp.	
240	**Platinum**	A	0.5–100%; any temp.	
242	**Ir-Plat.**	A	0.5–100%; any temp.	
244	**Rh-Plat.**	A	0.5–100%; any temp.	
245	**Pyrasteel**	V		BIVPTSCHF
249	**Resistac**	A	Glacial, conc. sol. only	BIVCHP
266	**Lead**	V	In absence of oxygen	PT
268	**Silver**	A	0.5–100%; any temp.	
270	**304-Clad**	A	Over 15%; boil.	BTSC
		A	All %; 70°	
271	**316-Clad**	A	All %; 70°	BTSC
274	**430-Clad**	A	Over 15%; boil.	BTSC
		A	All conc.; 70°	
275	**St. 301**	V	All %; Rm.	
276	**St. 302**	V	All %; Rm.	

No.	Material	Rating	Exposure Conditions	Applications
		A	All %; 70°	VTSCDF
		X	Over 15%; boil.	
		X	33%, 100% vapors; hot	
		A	10%, 50%, 100%; boil.	
		F	80%; boil.	
		X	100%; 400°; at 150 p.s.i.	
		A	Weak or medium	
		A	Conc.; cold	
		X	Conc.; boil.	
278	St. 303	V	All %; Rm.	
279	St. 304	V	All %; Rm.	
		A	All %; 70°	VTSCDF
		X	Over 15%; boil.	
		A	20% and 100%; 100°	P
		F	Glacial; boil.	BIVP
280	St. 308	V	All %; Rm.	
281	St. 309	V	All %; Rm.	
282	St. 310	V	All %; Rm.	
		A	5–100%; 70°	P
		A	20% and 100%; 100°	P
283	St. 316	V	All %; boil. (total immersion)	BIVPTCHDF
		A	All %; 70°	
		A	Over 15%; boil.	
		A	33% vapors; hot	
		X	100% vapors; hot	
		A	20% and 100%; 100°	
		A	Glacial; boil.	BIVP
		A	All %; 70° and boil.	
		A	100%; 400°; at 150 p.s.i.	
284	St. 317	V	All %; boil. (total immersion	BIVPTCHDF
		A	5–100%; 70°	P
		A	20% and 100%; 100°	P
285	St. 321	V	All %; Rm.	
286	St. 347	V	All %; Rm.	PT
287	St. 403	V	Glacial, 10%; Rm.	
288	St. 405	V	Glacial, 10%; Rm.	
290	St. 410	V	Glacial, 10%; Rm.	
		F	Glacial; boil.	BIVP
		A	10%; 70°	
		A	All %	
291	St. 414	V	Glacial, 10%; Rm.	
292	St. 416	V	Glacial, 10%; Rm.	
		A	All %	
293	St. 418	V	Glacial, 10%; Rm.	
294	St. 420	V	Glacial, 10%; Rm.	
		A	All %	
295	St. 430	V	Glacial; boil. (total immersion)	
		V	35%; Rm.	
		A	All %; 70°	VTSCHDFP
		X	Over 15%; boil.	
		A	20% and 100%; 100°	P
		A	100%; boil.	
		A	Weak	
		X	Medium or strong	
296	St. 430F	V	Glacial; boil. (total immersion)	
		V	33%; Rm.	
297	St. 431	V	Glacial; boil. (total immersion)	
		V	33%; Rm.	
298	St. 440A	V	Glacial; boil. (total immersion)	
		V	33%; Rm.	
300	St. 440C	V	Glacial; boil. (total immersion)	
		V	33%; Rm.	
301	St. 442	V	Glacial; boil. (total immersion)	
		V	33%; Rm.	
303	St. 446	V	Glacial; boil. (total immersion)	
		V	33%; Rm.	
309	St. CC-35	A	100%; Rm.-boil.	
316	St. CF-20	A		BIV
362	Still Met	A		BIVF
364	Steedy	A	10%-conc.; boil.	VF
365	Steody	A	10%-conc.; boil.	IVF
367	Super-Ni	F		PTCH
368	Tantalum	A	All %; 392° max.	CH
369	Telnic	A		
380	Tuf-Stuf	F	Cold	BIV
387	Stainless	A	All %	
388	Stainless	A	Weak; cold	
		X	Weak; boil.	
		X	Medium or strong	
389	Stainless	A	All %	
390	Worthite	A	All conditions	BIVPC
392	Wyndaloy	A	All %; 68°	
401	Karbate	A	All %; to boil.	BIVPTCHDR
402	Karbate	A	All %; to boil.	BIVPTCHDR

No.	Material	Rating	Exposure Conditions	Applications
403	Kempruf	A	All %; any temp.	PTDR
404	Acheson	A	All %; any temp.	PTDR
500	Sul. cement	A	200° max.	D, T, towers, trenches, floors, pipe joints
501	Sul. cement	A	200° max.	Same as above
502	Furan cem.	A	360° max.	Same as above
503	Furan cem.	A	360° max.	Same as above
504	Phen. cem.	A	360° max.	Same as above
505	Phen. cem.	A	360° max.	Same as above
506	Silicate cem.	F	360° max.	Same as above
507	Silicate cem.	A	300° max.	Same as above
508	Acichlor	V	Dil. and conc.; 300° max.	
510	Acitite	A	Dil. and conc.; 2,500° max.	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	200° max.	T
517	Carboline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
535	Nukem	A	350° max.	T
536	Nukem	A		T
537	Pecomastic	F	Dil. and conc.; 300° max.	F
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°–2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	360° max.	TD
544	Plastite	F	175° max.	PTSD
545	P-Basolit	A	200° max.	T
554	Silastic	A	(ASTM D-543-43)	
556	Staminite	A	All %; any temp.	TD
559	Thiokol	V	150° max.	
600	Acid Brick	A	1,200° max.	TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200–400° depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-l.	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All %; any temp.	BIPTDR
614	Glass-l.	A	All %; boil.; agitated	BTCH
616	Pyrex	A		
617	Stoneware	A	140–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
700	Ace Saran	A		P
703	Compar	X		
704	DC Silicone	A	ASTM D-543-43	HD
713	Haveg	A	All %; Rm. and boil.	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
720	Lamicoid	A		T
723	Nixon	X	5%; 77°	
724	Nixon	A	5%; 77°	S
725	Nixon	A	5%; 77°	S
726	Nukemite	A	5%; Rm.	PTSDF
727, 728	Nylon	A	Weak	
729–732	Nylon	X		
733	Permanite	A	300° max.	BVPTD
736	Pyroflex	V		PTCHD
737	Resilon	F	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	A	77°	PD
741	Sealon	A	Dil.; 160° max.	BPTDF
		X	Glacial	
742	Teflon	A	Rm.	VP
743	Textolite	A	Dil.-conc.; Rm.	T
744, 745	Textolite	F	Dil.; 77–122°; total immersion	BI
		X	Conc.; 77–122°; total immersion	
746	Tygon	V	Low conc.	BIPTSCDF
800	Ace Hd. Rub.	A		BIVPTDF
802	Acidseal	A	All %; 150° max.	BIPTDF
805	Butyl	A	30%; Rm.	
809	Fairprene	V		
814	GE Silicone	A	Dil.; Rm.	VIPT
		X	Conc.; Rm.	
817	Heresite	A	Glacial to 86°	
836	Natural (S)	V		
837	Natural (H)	A		
838	GR-S (S)	V		

No.	Material	Rating	Exposure Conditions	Applications
839	GR-S (H)	A		
840	GR-A (S)	X		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	X		
844	GR-I	V		
848	Silastic	A	(ASTM D-543-43)	
853	Thiokol	V	150° max.	T
854	Thiokol	X		
856	Triflex	A	30%; Rm.	
913	Redwood	A	40-80%; Rm.; 45 yr.	T
		A	30-40%; Rm.; Shellacked; food	T
		A	2-20%; 36-165° max.; lithography	T
		A	10%; 68-110°; Asphalt-L; vinegar	T
		A	10%; 36-80°; Asphalt-L; vinegar	T
		A	10%; 75-120°; 23 yr.; food	T
		A	10%; 70°; 18 yr.; vinegar	T
		A	6-10%; 60-90°; 13 yr.; food	T
		A	5-10%; 75°; Paraffined; 30 yr.; food	T
		A	2-5%; 36-80°; Painted; photo film	T

ALUM

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	F		CH
6	Adnic	A	70°	
10-17	Aluminum	AF	Rm.	BIPTSDF
19	Alloyco	A	10%, sat.; boil.	BV
22	Ambraloy	F		CH
23	Ambraloy	F		CH
24	Ambraloy	F		CH
29-40	Ampco	A		BIVPTCHDF
51	Berylco	A		
54	Brass	X		
61	Brass	X		
63	Brass	AF		PCH
66	Bronze	A		
73	Bronze	F		VT
74	Bronze	F		V
75	Bronze	F		VP
76	Bronze	F		
77	Bronze	X		
81	CA-FA20	A	10%; boil.	BIVP
82	CA-MM	A	10%; boil.	BIVP
86	Cast Iron	X		
111	Copper	A		
114	Copper	F		PTCHR
118	Copper	A		
119	Corrosiron	A	10%; Rm.	BIP
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
139	Durco	A	All %; any temp.	BIVHF
140	Durichlor	A	All %; any temp.	BIVPCHFR
141	Durimet	A	All %; any temp.	BIVHF
142	Durimet	A	All %; any temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	F		BIVR
149	Everdur	F		PTCHDR
150	Everdur	F		PCH
156	Gold	A	All %; any temp.	
196, 200, 266	Lead	A	All %	BIPTH
217	Monel-Clad	A		BTSCH
219	Muntz	X		
225	Ni-Clad	A		BTSCH
226	Nick-Sil	F		
234	Olympic	A		
235	Olympic	A		
236	Palladium	A	All %; any temp.	
240	Platinum	A	All %; any temp.	
242	Ir-Plat.	A	All %; any temp.	
244	Rh-Plat.	A	All %; any temp.	
245	Pyrasteel	A		BIVPTSCHDF
268	Silver	A	All %; any temp.	
270	304-Clad	A	10% max.	BTSCH
271	316-Clad	A	10% max.	BTSCH
275	St. 301	V		
276	St. 302	V		
		A	10%; any temp.	VTSCDF
		F	Sat.; boil.	
278	St. 303	V		
279	St. 304	V		
		A	10%; any temp.	VTSCDF
		A	10%; boil.	BIVP
280	St. 308	V		
281	St. 309	V		

No.	Material	Rating	Exposure Conditions	Applications
282	St. 310	V		
283	St. 316	A		BIVPTSCH
		A	10%; any temp.	VTCHDF
		A	10%; boil.	BIVP
		A	Sat.; boil.	
284	St. 316	A		BIVPTSCH
285	St. 321	V		
286	St. 347	V		
287	St. 403	V		
288	St. 405	V		
290	St. 410	V		
		X	10%; boil.	
291	St. 414	V		
292	St. 416	V		
293	St. 418	V		
294	St. 420	V		
295	St. 430	V		
		X	10%; any temp.	
		A	10%; 70°	
		F	10%; boil.	
		X	Sat.; boil.	
296	St. 430F	V		
297	St. 431	V		
298	St. 440A	V		
300	St. 440C	V		
301	St. 442	V		
303	St. 446	V		
316	St. CF-20	A		
318	St. CF-7C	A	10%; Rm.-boil.	
319	St. CF-7M	A	10%; Rm.-boil.	
367	Super-Ni	A		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	A		
390	Worthite	A	All conditions	BIV
401	Karbate	A	All %; to boil.	BIPH
402	Karbate	A	All %; to boil.	BIPH
403	Kemprul	A	All %; any temp.	T
404	Acheson	A	All %; any temp.	T
500	Sul. cement	V	200° max.	D, T, towers trenches, floors, pipe joints.
501	Sul. cement	V	200° max.	Same as 500
502	Furan cem.	V	360° max.	Same as 500
503	Furan cem.	V	300° max.	Same as 500
504	Phen. cem.	V	360° max.	Same as 500
505	Phen. cem.	V	360° max.	Same as 500
506	Silicate cem.	V	1,800° max.	Same as 500
507	Silicate cem.	V	1,600° max.	Same as 500
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	200° max.	T
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350°	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
532	Lumnite	A	10% max.; 90° max.	TD
534	N-Series	A	Sat.; 160°	BIVPTCDF
535	Nukem	A	350° max.	T
536	Nukem	F		T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500-2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	300° max.	TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A	200° max.	T
559	Thiokol	A		
600	Acid Brick	A	1,200° max.	
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200-400° depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
611	Porcelain	A	All %; any temp.	BIPTDR
614	Glass-L	A	All conc.; 250° max.; agitated	BTCH
616	Pyrex	A		
617	Stoneware	A	140-160°	BIPTSCHFDR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	A		P
711	Haveg	A	All %; 300° max.	BIVPTDFR
713	Haveg	A	All %; 300° max.	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	A	All %; 180° max.	TD

No.	Material	Rating	Exposure Conditions	Applications
720	Lamicoid	A		T
726	Nukemite	A	150° max.	PTSDF
733	Permanite	A	300° max.	BVPDT
737	Resilon	A	175° max.	PTSD
742	Teflon	A	Rm.	VP
746	Tygon	A	All %; 180° max.	BIPTSCDF
800	Ace Hd. Rub.	A		BIVPTDF
801	Acidseal	A	All %; 150° max.	BIPTSDF
802	Acidseal	A	All %; 150° max.	BIPTSDF
805	Butyl	A	Dry salt; aqueous sol. at Rm.	
809	Fairprene	A		
817	Heresite	A	Sat.; 212° max.	
835	Perbunan	A	Dry salt; aqueous sol. at Rm.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTSDF
849	Superflex.	A	All %; 150° max.	BIPTSDF
853	Thiokol	A	150° max.	T
854	Thiokol	A		PTSCDF
855	Triflex	A	All %; 150° max.	BIPTSDF
856	Triflex	A	Dry salt; aqueous sol. at Rm.	

ALUMINUM CHLORIDE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	F		CH
6	Adnic	A	70°	
10-17	Aluminum	V	Sol.; rm.	
22	Ambraloy	F		CH
23	Ambraloy	F		CH
24	Ambraloy	F		CH
29-40	Ampco	A		BIVPTCHDF
42	Antaciron	A	All conditions	BIV
54	Brass	X		
61	Brass	X		
63	Brass	FV		PCH
66	Bronze	V		
73	Bronze	F		VT
74	Bronze	F		V
75	Bronze	F		VP
76	Bronze	F		Instruments
77	Bronze	X		
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All %; moderate temp.	BIVCHF
111	Copper	V		
114	Copper	F		PTCHR
118	Copper	V		
123	Cupro-Ni	F		CH
124	Cupro-Ni	V		
139	Durco	A	All % at moderate temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % at moderate temp.	BIVHF
142	Durimet	A	All % at rm.	BIVHF
143	Duriron	A	All % and temp.; 140 preferred	BIVPHFR
148	Everdur	F		BIVR
149	Everdur	F		PTCHDR
150	Everdur	F		PCH
156	Gold	A		
159	Hastelloy	A	All %; 160° max.	BIVPT
160	Hastelloy	A	All %; any temp.; also as dry catalyst with organics up to 300°	BIVPTCHDF
161	Hastelloy	A	All %; 125° max.	BIVPT
162	Hastelloy	A	Rm. max.	V
163	Stellite	A	Moist; rm. max.; dry; 300° max.	BIV
165	Stellite	F	Moist; rm. max.; dry; 300° max.	BIV
184	Inconel	V	26%; 65°	
196, 200, 266	Lead	A		TC
216	Monel	A	26%; 65°	VT
217	Monel-Clad	A		BTSCH
219	Muntz	X		
224	Nickel	A	65%; 65°	
226	Nick-Sil.	F		Instruments
231	Ni-Resist	F	26%; 65°	
234	Olympic	V		
235	Olympic	V		
236	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
245	Pyrasteel	X		
249	Resistac	A		BIVCHF
266	Lead	A		TC
268	Silver	A		
275	St. 301	X		
276	St. 302	X		
278	St. 303	X		
279	St. 304	X		
280	St. 308	X		
281	St. 309	X		
282	St. 310	X		
283	St. 316	V		
284	St. 317	V		
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
316	St. CF-20	A		BIV
319	St. CF-7M	A	Sat.; 100°	
367	Super-Ni.	F		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	V		
390	Worthite	F	Cold, weak	BIV
401	Karbate	A	All %; to boil.	BIVPH
402	Karbate	A	All %; to boil.	BIVPH
403	Kempruf	A	All %; any temp.	TR
404	Acheson	A	All %; any temp.	TR
500	Sul. cement	A	Solutions; 200° max.	PT
501	Sul. cement	A	Solutions; 200° max.	PT
502	Furan cement	A	Solutions; 360° max.	PT
503	Furan cement	A	Solutions; 360° max.	PT
504	Phen. cement	A	Solutions; 360° max.	PT
505	Phen. cement	A	Solutions; 360° max.	PT
506	Silicate cement	A	Solutions; 1600° max.	PT
507	Silicate cement	A	Solutions; 1600° max.	PT
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	200° max.	T
517	Carboline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	A	25%; Rm.	BIVPTCDF
535	Nukem	A	350° max.	T
536	Nukem	A		T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°-2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A		TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A	200° max.	T
554	Silastic	A	ASTM D-543-43	
556	Staminite	A	All %	TD
559	Thiokol	X		
600	Acid Brick	A	1,200° max.	TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All %; any temp.	BIPTDR
614	Glass-L	A	All %; 250° max.; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		

No.	Material	Rating	Exposure Conditions	Applications
700	Ace Saran	A		P
704	DC Silicone	A	ASTM D-543-43	HD
711	Haveg	A	All %; 300° max.	BIVPTDFR
713	Haveg	A	All %; 300° max.	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Karbate	A	All %; 150° max.	TD
720	Lamicoid	A		T
726	Nukemite	A	150° max.	PTSDF
733	Permanite	A	300° max.	BVPDT
736	Pyroflex	A		PTCHD
737	Resilon	A	175° max.	PTSD
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	A	180° max.	BIPTSCDF
800	Ace Hd Rubber	A		
801	Acidseal	A	All %; 150° max.	BIPTSDF
802	Acidseal	A	All %; 150° max.	BIPTSDF
805	Butyl	A	Dry salt; aqueous sol.; rm.	
809	Fairprene	A		
817	Heresite	A	Sat.; 212° max.	
835	Perbunan	A	Dry salt; aqueous sol.; rm.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTSDF
848	Silastic	A	ASTM D-543-43	
849	Superflex	A	All %; 150° max.	BIPTSDF
853	Thiokol	V	150° max.	T
854	Thiokol	V	150° max.	PTSCDF
855	Triflex	A	All %; 150° max.	BIPTSDF
856	Vistanex	A	Dry salt; aqueous sol.; rm.	

AMMONIA

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	X		
4	Admiralty	A	Dry	CH
		X	Moist	
6	Adnic	V		
10-17	Aluminum	A	Dry; any temp.	BIPTSCHDF
		AV	All %; Rm., boil.	BIPTSCHDF
22	Ambraloy	A	Dry	CH
		X	Moist	
23	Ambraloy	A	Dry	CH
		X	Moist	
24	Ambraloy	A	Dry	CH
		X	Moist	
54	Brass	A	Dry	CH
		X	Moist	
61	Brass	A	Dry	VCH
		X	Moist	
63	Brass	A	Dry	PCH
		X	Moist	
66	Bronze	X		
73	Bronze	A	Dry	VT
		X	Moist	
74	Bronze	A	Dry	V
		X	Moist	
75	Bronze	A	Dry	VP
		X	Moist	
76	Bronze	A	Dry	Instruments
		X	Moist	
77	Bronze	A	Dry	PCH
		X	Moist	
81	CA-FA20	A	Conc. sol.; 70°	BIVP
82	CA-MM	V	Conc. sol.; 70°	BIVP
85	Cast Iron	A	Aqua	
86	Cast Iron	A		
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	X		
114	Copper	A	Dry	PTCHR
		X	Moist	
118	Copper	X		
123	Cupro-Ni	A	Dry	CH
		X	Wet	
124	Cupro-Ni	F		
127-133	Dowmetal	A	Liquid or hydroxide	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % and temp.	BIVHF
142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A	Dry	BIVR
		X	Moist	
149	Everdur	A	Dry	PTCHDR
		X	Moist	
150	Everdur	A	Dry	PCH
		X	Moist	
156	Gold	A	All % and temp.	
159	Hastelloy	A	Wet; any temp.	BIVPTCH
160	Hastelloy	A	Wet; any temp.	BIVPTCH
161	Hastelloy	A	Wet; any temp.	BIVPTCH
162	Hastelloy	A	Wet; any temp.	BIVPS
163	Stellite	A	Wet; any temp.	BIV
165	Stellite	A	Wet; any temp.	BIV
184	Inconel	A	All %; 70°	
185	Inc-Clad	A		BTSCH
216	Monel	A	2.7%; 70°; aerated	(VP, anhyd.) (V, aqua)
		X	10%; 70°; aerated	
217	Monel-Clad	A		BTSCH
219	Muntz	A	Dry	CH
		X	Moist	
224	Nickel	A	Hydroxide; 1.1%; 70°; aerated	P
		X	Hydroxide; 2.7%; 70°; aerated	
		X	Hydroxide; 10%; 70°; aerated	
225	Ni-Clad	A		BTSCH
226	Nick-Sil	A	Dry	Instruments
		X	Moist	
231	Ni-Resist	A	All %; 70°	(BV, anhyd)(BIV, aqua)
234	Olympic	X		
235	Olympic	X		
236	Palladium	A	All % and temp.	
240	Platinum	A	All % and temp.	
242	Ir-Plat.	A	All % and temp.	
244	Rh-Plat.	A	All % and temp.	
245	Pyrasteel	A		BIVPTSCHF
268	Silver	A	Oxygen-free sol. to 160°	
		X	Over 160°; anhydrous	
270	304-Clad	A	All %; 70°	BTSCH
271	316-Clad	A	All %; 70°	BTSCH
274	430-Clad	A	All %; 70°	BTSCH
275	St. 301	A		BIVTSCH
276	St. 302	A		BIVTSCH
		A	All %; 70°	VTSCDF
		X	Gas; hot	
		A	Sp. gr. 0.91; 70°; boil. gas liquor	
278	St. 303	A		TV
279	St. 304	A		BIVPTSCHDF
		A	All %; 70°	VTSCDF
		X	Gas; hot	
		A	Conc.; 70°	BIVPT
280	St. 308	A		BIVPTSCHDF
281	St. 309	A		BIVTSCHDF
282	St. 310	A		BIVPTSCHDF
283	St. 316	A		BIVPTSCHDF
		A		VTCHDF
		A	Conc.; 70°	BIVPT
284	St. 317	A		BIVPTSCHDF
285	St. 321	A		BIVPT
286	St. 347	A		BIVPTSCHDF
287	St. 403	A		IV
288	St. 405	A		BIVTSCHDF
290	St. 410	A		BIVPTSCHDF
		A	Conc.; 70°	BIVP
291	St. 414	A		IV
292	St. 416	A		IV
293	St. 418	A		
294	St. 420	A		
295	St. 430	A		BIVPTSCHDF
		X	Gas; hot	
		A	All %; 70°	VTSCHDF
		A	Sp. gr. 0.91; 70°; boil. gas liquor	
296	St. 430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSCHDF
303	St. 446	A		BIVPTSCHDF
313	St. CF-7	A	All %; Rm.-boil.	

No.	Material	Rating	Exposure Conditions	Applications
318	St. CF-7C	A	All %; Rm.-boil.	
319	St. CF-7M	A	All %; Rm.-boil.	
338	St. CK-25	A	All %; Rm.-boil.	
367	Super-Ni	A	Dry	PTCH
		V	Moist	PTCH
368	Tantalum	X		
369	Telnic	X		
401	Karbate	A	All %; to boil.	BIVPCHF
402	Karbate	A	All %; to boil.	BIVPCHF
403	Kemprul	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	F	200° max.	T
501	Sul. cement	F	200° max.	T
502	Furan cement	A	360° max.	PT
503	Furan cement	A	360° max.	PT
504	Phen. cement	A	300° max.	PT
505	Phen. cement	A	360° max.	PT
506	Silicate cement	X	1,600° max.	
507	Silicate cement	X	1,600° max.	
508	Acichlor	A	Dilute and conc.; 300° max.	
510	Acitite	V	Dilute and conc.; 250° max.	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	X		
518	C-Basolit	X		
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
535	Nukem	A		T
536	Nukem	A		T
539	Penchlor	A	All %; 750° max.	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A		TD
544	Plastite	V	175° max.	PTSD
545	P-Basolit	X		
554	Silastic	A	ASTM D-543-43	
556	Staminite	X		
559	Thiokol	A	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	Not commonly used	
607	Glass-L	V		PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	V		BTCH
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	V	1,000° max.	
619	Vitreosil	A		
700	Ace Saran	X		
703	Compar	X		
704	DC Silicone	A	ASTM D-543-43	HD
706	Formica	A	Conc.; Rm.	PTF
713	Haveg	A	300° max.	BIVPTDFR
715	Heresite	A	300° max.	
716	Heresite	A	200° max.	
720	Lamicoid	A		T
726	Nukemite	A		PTSDF
727	Nylon	A		
728	Nylon	A		
729-732	Nylon	A		
733	Permanite	A	360° max.	BVPDT
736	Pyroflex	A		PTCHD
737	Resilon	V	175°	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	X	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	V	180° max.	BIPTSCDF
800	Ace Hd Rubber	A		BIVPTDF
801	Acidseal	A	Up to sat.; 150° max.; in water	BIPTDF
817	Heresite	A	Sat.; 212° max.; aqueous sol.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	Up to sat.; 150° max.; in water	BIPTDF
848	Silastic	A	ASTM D-543-43	
849	Superflex	A	Up to sat.; 150° max.; in water	BIPTDF
853	Thiokol	V	150° max.	T
854	Thiokol	A	150° max.	PTSCDF

AMMONIUM SULPHATE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	F		
4	Admiralty	V		CH
6	Adnic	V	All %; 70°	
10-17	Aluminum	A	5% max.; Rm.	PT
		A	Dry powders	
19	Alloyco	A	10%, Sat.; boil.	BV
		A	Plus free H_2SO_4 @ 150°	BV
22	Ambraloy	V		CH
23	Ambraloy	V		CH
24	Ambraloy	V		CH
29-40	Ampco	A		BIVPTSCHDF
54	Brass	X		
61	Brass	X		
63	Brass	VF		PCH
66	Bronze	F		
73	Bronze	V		VT
74	Bronze	V		V
75	Bronze	V		VP
76	Bronze	V		Instruments
77	Bronze	X		
81	CA-FA20	A	10%; boil.	BIVP
82	CA-MM	A	10%; boil.	BIVP
85	Cast Iron	A		
86	Cast Iron	A		
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHDF
111	Copper	F		
114	Copper	V		PTCHR
117	Copper	V		P
118	Copper	F		
119	Corrosiron	A	25%; Rm.	BIP
123	Cupro-Ni	V		CH
124	Cupro-Ni	F		
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % and temp.	BIVHF
142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	V		BIVP
149	Everdur	V		PTCHDR
150	Everdur	V		PCH
159	Hastelloy	A	All % to 180°	BIVPT
160	Hastelloy	A	All % to boil.	BIVPTCH
161	Hastelloy	A	All % to boil.	BIVPTCH
162	Hastelloy	A	All % to boil.	BIVP
163	Stellite	A	All %; Rm.	BIV
165	Stellite	A	All %; Rm.	BIV
184	Inconel	A	Sat. plus 5% sulphuric; 150°	
193, 196, 200, 266	Lead	A	Various %; Rm.	PT
216	Monel	A	Sat. plus 5% sulphuric; 150°	BIVPTHDF
217	Monel-Clad	A		BTSCH
219	Muntz	X		
224	Nickel	F	Sat. plus 5% sulphuric; 150°	PH
225	Ni-Clad	A		BTSCH
226	Nick-Sil.	V		Instruments
231	Ni-Resist	A	Sat. plus 5% sulphuric; 150°	BIV
234	Olympic	F		
235	Olympic	F		
245	Pyrasteel	V		BIVPTSCHF
249	Resistac	A		BIVCHF
270	304-Clad	A	1, 5%; 70°	BTSCH
271	316-Clad	A	1, 5%; 70°	BTSCH
274	430-Clad	A	1, 5%; 70°	BTSCH
275	St. 301	A		BIVTSCH
276	St. 302	A		BIVTSCH
		A	1%; 50%; 70°	VTSCDF
		X	10% Sat.; boil.	
		A	10%; Sat. cold; boil.	
278	St. 303	A		IV
279	St. 304	A		BIVPTSCHDF
		A	1%; 5%; 70°	VTSCDF
		X	10% Sat.; boil.	
		A	10%; boil.	BIVP
280	St. 308	A		BIVPTSCH
281	St. 309	A		BIVTSCH
282	St. 310	A		BIVPTSCH
283	St. 316	A		BIVPTSCH
		X	10% Sat.; boil.	

No.	Material	Rating	Exposure Conditions	Applications
		A	10%; Sat. cold; boiling	
		A	10%; boil.	BIVP
284	St. 317	A		BIVPTSCH
285	St. 321	A		BIVPTSCH
286	St. 347	A		BIVPTSCH
287	St. 403	F	Rm.	
288	St. 405	F		
290	St. 410	F	Rm.	
		X	10%; boil.	
291	St. 414	F	Rm.	
292	St. 416	F	Rm.	
293	St. 418	F	Rm.	
294	St. 420	F	Rm.	
295	St. 430	A		BIVPTSCHDF
		A	1%; 50%; 70°	VTSCHDF
296	St. 430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSCH
303	St. 446	A		BIVPTSCH
316	St. CF-20	A		BIV
318	St. CF-7C	A	Conc.; Rm.-boil.	
319	St. CF-7M	A	Conc.; Rm.-boil.	
367	Super-Ni	F		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	F		
390	Worthite	A	All %; any temp.	BIV
401	Karbate	A	All %; to boil.	BIVPH
402	Karbate	A	All %; to boil.	BIVPH
403	Kempruf	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	A	200° max.	PT
501	Sul. cement	A	200° max.	PT
502	Furan cement	A	360° max.	PT
503	Furan cement	A	360° max.	PT
504	Phen. cement	A	360° max.	PT
505	Phen. cement	A	360° max.	PT
506	Silicate cement	V	1,600° max.	T
507	Silicate cement	V	1,600° max.	T
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	200° max.	T
517	Carboline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
532	Lumnite	A		TD
535	Nukem	A		T
536	Nukem	A		T
539	Penchlor	A	All %; 750° max.	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A		TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A	200° max.	T
554	Silastic	A	ASTM D-543-43	
559	Thiokol	A	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHFDR
606	Stoneware	A	All conditions	BIVPTCHFDR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-I	A	All %; under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	A		P
704	DC Silicone	A	ASTM D-543-43	HD
711	Haveg	A	All %; 300° max.	BIVPTDFR
713	Haveg	A	All %; 300° max.	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	A	All %	TD
720	Lamicoid	A		T
726	Nukemite	A		PTSDF
733	Permanite	A	360° max.	BVPDT
736	Pyroflex	A		PTCHD
737	Resilon	A	175° max.	PTSD
740	Saran	A	77°	
741	Sealon	A	100° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	A	180° max.	BIPTSCDF
800	Ace Hd. Rubber	A		BIVPTDF
801	Acidseal	A	All %; 150° max.	BIPTDF
802	Acidseal	A	All %; 150° max.	BIPTDF
809	Fairprene	A		
817	Heresite	A	Sat.; 212° max.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTDF
848	Silastic	A	ASTM D-543-43	
849	Superflex	A	All %; 150° max.	BIPTDF
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	A	All %; 150° max.	BIPTDF

BENZOL

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	A		CH
6	Adnic	A		
10-17	Aluminum	A	Rm., boil.	BIPTSCHDF
22	Ambraloy	A		CH
23	Ambraloy	A		CH
24	Ambraloy	A		CH
29-40	Ampco	A		BIVPTCHDF
51	Berylco	A		
54	Brass	A		CH
61	Brass	A		VCH
63	Brass	A		PCH
66	Bronze	A		
73	Bronze	A		VT
74	Bronze	A		V
75	Bronze	A		VP
76	Bronze	A		Instruments
77	Bronze	A		PCH
85	Cast Iron	A		
86	Cast Iron	A		
87	Causul	A	All %; any temp.	B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	A		
114	Copper	A		PTCHR
117	Copper	A		P
118	Copper	A		
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
127-133	Dowmetal	A		
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	CHFR
141	Durimet	A	All % and temp.	BIVHF
142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A		BIVR
149	Everdur	A		PTCHDR
150	Everdur	A		PCH
156	Gold	A	Any temp. to cracking temp.	
159	Hastelloy	A	All conc. to boil.	
160	Hastelloy	A	All conc. to boil.	
161	Hastelloy	A	All conc. to boil.	
162	Hastelloy	A	All conc. to boil.	
163	Stellite	A	All conc. to boil.	BIV
165	Stellite	A	All conc. to boil.	BIV
184	Inconel	A	Boil.	
216	Monel	A	Boil.	VC
216	Monel-Clad	A		BTSCH
219	Muntz	A		CH
224	Nickel	A	Boil.	T
225	Ni-Clad	A		BTSCH
226	Nick-Sil	A		Instruments
231	Ni-Resist	A	Boil.	BI
234	Olympic	A		
235	Olympic	A		
236	Palladium	A	Any temp. to cracking temp.	
240	Platinum	A	Any temp. to cracking temp.	
242	Ir-Plat.	A	Any temp. to cracking temp.	
244	Rh-Plat.	A	Any temp. to cracking temp.	

No.	Material	Rating	Exposure Conditions	Applications
245	Pyrasteel	A		BIVPTSCHF
268	Silver	A	Any temp. to cracking temp.	
270	304-Clad	A	All %; any temp.	BTSCH
271	316-Clad	A	All %; any temp.	BTSCH
274	430-Clad	A	All %; any temp.	BTSCH
275	St. 301	A		BIVTSCHDF
276	St. 302	A		BIVTSCHDF
		A	Hot	
		A	Any temp.	VTSCDF
278	St. 303	A		IV
279	St. 304	A		BIVPTSCDF
		A	Any temp.	VTSCDF
280	St. 308	A		BIVPTSCDF
281	St. 309	A		BIVTSCHDF
282	St. 310	A		BIVPTSCHDF
283	St. 316	A		BIVPTSCDF
		A	Hot	
		A	Any temp.	VTCHDF
284	St. 317	A		BIVPTSCDF
285	St. 321	A		BIVPTSC
286	St. 347	A		BIVPTSCH
287	St. 403	A		IV
288	St. 405	A		BIVTSC
290	St. 410	A		BIVPTSCDF
291	St. 414	A		IV
292	St. 416	A		IV
293	St. 418	A		
294	St. 420	A		
295	St. 430	A		BIVPTSCHDF
		A	Any temp.	VTSCHDF
296	St. 430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSCHDF
303	St. 446	A		BIVPTSCDF
308	St. CB-30	A	High temp.	
367	Super-Ni	A		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	A		
401	Karbate	A	All %; to boil.	BIVP
402	Karbate	A	All %; to boil	BIVP
403	Kempruf	A	All %; any temp.	T
404	Acheson	A	All %; any temp.	T
500	Sul. cement	X		
501	Sul. cement	X		
502	Furan cement	A	360° max.	PTD
503	Furan cement	A	300° max.	PTD
504	Phen. cement	A	360° max.	PTD
505	Phen. cement	A	360° max.	PTD
506	Silicate cement	F	1,600° max.	TD
507	Silicate cement	F	1,600° max.	TD
508	Acichlor	X		
510	Acitite	F	Dilute and conc.; 250° max.	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A		T
517	Carboline	A		
518	C-Basolit	A		T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	X		
535	Nukem	A		T
536	Nukem	A		T
537	Pecomastic	X		
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 800°-2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A		TD
544	Plastite	X		
545	P-Basolit	A		T
554	Silastic	X	ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	Not commonly used	
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	Under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	F		P
703	Compar	A	Conc.; −40° to boil.	TD
704	DC Silicone	X	ASTM D-543-43	
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	X		
720	Lamicoid	A		T
723	Nixon	A	77°	
724	Nixon	A	77°	S
733	Permanite	A	360° max.	BVPDT
736	Pyroflex	V		PTCHD
737	Resilon	X		
738	Resistoflex	A	Conc.; to boil.	P
739	Resistoflex	A	Conc.; 275° max.	IVP
740	Saran	V	77°	
741	Sealon	X		
742	Teflon	A	Rm.	VP
744	Textolite	A	77°-122°	BI
745	Textolite	A	77°-122°	BI
746	Tygon	X		
800	Ace Hd. Ru.	X		
801	Acidseal	X		
802	Acidseal	X		
805	Butyl	X		
817	Heresite	X		
835	Perbunan	V		
836	Natural (S)	X		
837	Natural (H)	X		
838	GR-S (S)	X		
839	GR-S (H)	X		
840	GR-A (S)	X		
841	GR-A (H)	F		
842	GR-M (S)	X		
843	GR-P (S)	V		
844	GR-I	X		
846	Saniprene	X		
848	Silastic	X		
849	Superflex	X		
853	Thiokol	F	150° max.	T
854	Thiokol	V	150° max.	PTSCDF
855	Triflex	X		
856	Vistanex	X		

BROMINE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A	Dry	
		V	Moist	
4	Admiralty	A	Dry	CH
		V	Moist	
6	Adnic	A	Dry gas	
10-17	Aluminum	X		
22	Ambraloy	A	Dry	CH
		V	Moist	
23	Ambraloy	A	Dry	CH
		V	Moist	
24	Ambraloy	A	Dry	CH
		V	Moist	
29-40	Ampco	V		
54	Brass	A	Dry	CH
		X	Moist	
61	Brass	A	Dry	VCH
		X	Moist	
63	Brass	A	Dry	PCH
		V	Moist	
66	Bronze	A	Dry	
		V	Moist	
73	Bronze	A	Dry	VT
		V	Moist	
74	Bronze	A	Dry	V
		V	Moist	
75	Bronze	A	Dry	VP
		V	Moist	
76	Bronze	A	Dry	Instruments
		V	Moist	
77	Bronze	A	Dry	PCH
		X	Moist	
88	Chlorimet	A	Dry; all temp.	BIVCHF
		X	Wet	

No.	Material	Rating	Exposure Conditions	Applications
89	Chlorimet	A	Dry; all temp.	BIVCHF
		X	Wet	
111	Copper	A	Dry	
		V	Moist	
114	Copper	A	Dry	PTCHR
		V	Moist	
118	Copper	A	Dry	
		V	Moist	
123	Cupro-Ni	A	Dry	CH
		V	Moist	
124	Cupro-Ni	A	Dry	
		V	Moist	
127–133	Dowmetal	A*	Dry	
139	Durco	X		
140	Durichlor	X		
141	Durimet	X		
142	Durimet	X		
143	Duriron	X		
148	Everdur	A	Dry	BIVR
		V	Moist	
149	Everdur	A	Dry	PTCHDR
		V	Moist	
150	Everdur	A	Dry	PCH
		V	Moist	
156	Gold	X		
159	Hastelloy	F	Dry only	
160	Hastelloy	A	HBr; any temp.	BIVPTCH
161	Hastelloy	A	Wet gas; Rm. only	BIVPTCH
162	Hastelloy	F	Dry only	
163	Stellite	A	Wet gas; Rm. only	BIV
165	Stellite	A	Wet gas; Rm. only	BIV
184	Inconel	A	Dry	
		X	Wet	
216	Monel	A	Dry	
		X	Wet	
219	Muntz	A	Dry	CH
		X	Moist	
224	Nickel	A	Dry	
		X	Wet	
226	Nick-Sil.	A	Dry	Instruments
		V	Moist	
231	Ni-Resist	A	Dry	
		X	Wet	
234	Olympic	A	Dry	
		V	Moist	
235	Olympic	A	Dry	
		V	Moist	
240	Platinum	A	Rm.	
		X	Elevated temp.	
242	Ir-Plat.	A	Rm.	
		X	Elevated temp.	
244	Rh-Plat.	A	Rm.	
		X	Elevated temp.	
245	Pyrasteel	A		BIVPTSCHF
268	Silver	X		
275	St. 301	X		
276	St. 302	X		
		X	70°	
		X	70°; Bromine water	
278	St. 303	X		
279	St. 304	X		
		X	70°; Bromine water	
280	St. 308	X		
281	St. 309	X		
282	St. 310	X		
283	St. 316	X		
		X	70°	
		X	70°; Bromine water	
284	St. 317	X		
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
		X	70°	
		X	70°; Bromine water	
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
367	Super-Ni	A	Dry	PTCH
		V	Moist	
368	Tantalum	A	302° max.	CH
369	Telnic	A	Dry	
		V	Moist	
390	Worthite	X		
401	Karbate	V		
403	Kempruf	V		
500	Sul. cement	F	120° max.	T
501	Sul. cement	F	120° max.	T
502	Furan cement	F	360° max.	T
503	Furan cement	F	360° max.	T
504	Phen. cement	F	360° max.	T
505	Phen. cement	F	360° max.	T
506	Silicate cement	F	1,600° max.	T
507	Silicate cement	F	1,600° max.	T
513	Asplit	X		
514	Asplit-F	X		
515	Basolit	A		T
518	C-Basolit	A		T
523	Duralon	X		
524	Durisite	X		
535	Nukem	X		
536	Nukem	A		T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°–2,000°	
541	Pennsalt	X		
542	Permanite	X		
544	Plastite	V	175° max.	PTSD
545	P-Basolit	A		T
554	Silastic	X	ASTM D-543-43	
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	V	Under 212°; small capacity units	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	V	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
700	Aco Saran	X	Liquid	
703	Compar	X		
704	DC Silicone	X	ASTM D-543-43	
711	Haveg	X		
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
720	Lamicoid	X		
726	Nukemite	A		PTSDF
733	Permanite	X		
736	Pyroflex	V		PTCHD
737	Resilon	V	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	X	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	V	180° max.	
805	Butyl	X		
809	Fairprene	X		
817	Heresite	V	Sat.; 212° max.	
835	Perbunan	X		
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	V		
843	GR-P (S)	X		
844	GR-I	V		
848	Silastic	X		
853	Thiokol	X		
854	Thiokol	X		
856	Vistanex	X		

CALCIUM HYPOCHLORITE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	F		CH
6	Adnic	V	Dil. sol.; 70°	
10-17	Aluminum	V	Rm.	
22	Ambraloy	F		CH
23	Ambraloy	F		CH
24	Ambraloy	F		CH
29-40	Ampco	F	May be erratic	BIVPTCHDF
42	Antaciron	A	All conditions	
54	Brass	X		
61	Brass	X		
63	Brass	FV		PCH
66	Bronze	V		
73	Bronze	F		VT
74	Bronze	F		V
75	Bronze	F		VP
76	Bronze	F		Instruments
77	Bronze	X		
81	CA-FA20	A	2%; 70°	BIVP
82	CA-MM	X	2%; 70°	
85	Cast Iron	A		
86	Cast Iron	V		
88	Chlorimet	X		
89	Chlorimet	A	All %; moderate temp.	BIVCHF
111	Copper	V		
114	Copper	F		PTCHR
117	Copper	V	Dil. sol.	P
118	Copper	V		
123	Cupro-Ni	F		CH
124	Cupro-Ni	V		
139	Durco	V	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	V	All % and temp.	BIVHF
142	Durimet	V	All % and temp.	BIVHF
143	Duriron	A	All % and temp. (140 preferred)	BIVPHFR
148	Everdur	F		BIVR
149	Everdur	F		PTCHDR
150	Everdur	F		PCH
159	Hastelloy	X		
160	Hastelloy	X		
161	Hastelloy	A	Rm. only	BIVPTSC
162	Hastelloy	X		
163	Stellite	A	Rm. only	BIV
165	Stellite	X		
184	Inconel	A	3 g.p.l. max. free Cl_2; 70°	
		X	Over 3 g.p.l. free Cl_2; 70°	
216	Monel	A	3 g.p.l. max. free Cl_2; 70°	V
		X	Over 3 g.p.l. free Cl_2; 70°	
219	Muntz	X		
224	Nickel	A	3 g.p.l. max. free Cl_2; 70°	
		X	Over 3 g.p.l. free Cl_2; 70°	
226	Nick-Sil.	F		Instruments
231	Ni-Resist	A	0.07%; 60°	BIV
		X	Over 3 g.p.l. free Cl_2; 70°	
233	NS-5	A	Bleach liquor; cold	V
234	Olympic	V		
235	Olympic	V		
240	Platinum	A	All temp.	
242	Ir-Plat.	A	All temp.	
244	Rh-Plat.	A	All temp.	
245	Pyrasteel	V		BIVPTSCHF
275	St. 301	V		
276	St. 302	V		
		A	2%; 70°	VTSCDF
278	St. 303	V		
279	St. 304	V		
		A	2%; 70°	VTSCDF
		V	2%; 70°	BIVP
280	St. 308	V		
281	St. 309	V		
282	St. 310	V		
283	St. 316	A		BIPTS
		A	2%; 70°	VTCHDF
284	St. 317	A		VP
285	St. 321	V		
286	St. 347	V		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
		X	2%; 70°	
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
		A	2%; 70°	VTSCHDF
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
367	Super Ni	F		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	V		
390	Worthite	A	All %; any temp.	BIV
401	Karbate	A	70% max.	BIV
402	Karbate	A	70% max.	BIV
403	Kempruf	F	All %; any temp.	
404	Acheson	F	All %; any temp.	
500	Sul. cement	F	Dilute sol.; low temp. only	T
501	Sul. cement	F	Dilute sol.; low temp. only	T
502	Furan cement	F	Dilute sol.; low temp. only	T
503	Furan cement	F	Dilute sol.; low temp. only	T
504	Phen. cement	F	Dilute sol.; low temp. only	T
505	Phen. cement	F	Dilute sol.; low temp. only	T
506	Silicate cement	X		
507	Silicate cement	X		
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A		T
518	C-Basolit	A		T
521	Causplit	A	All %; 350° max.	
523	Duralon	V	350° max.	BIPTCHDF
524	Durisite	V	350° max.	BIPTCHDF
535	Nukem	A	350° max.	T
536	Nukem	A		T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°-2,000°	
541	Pennsalt	A	All %; 350°	
542	Permanite	V		TD
544	Plastite	A	175° max.	TPSD
545	P-Basolit	A		T
554	Silastic	F	ASTM D-543-43	
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	V		PTCH
610	Stoneware	A	All %; any temp.	BIVTPCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	V	Under 77°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	A		P
704	DC Silicone	F	ASTM D-543-43	HD
713	Haveg	F	All conditions	BIVPTDFR
715	Heresite	A	5% at 70°	
716	Heresite	A	5% at 70°	
720	Lamicoid	X		
726	Nukemite	A		PTSDF
733	Permanite	V	360° max.	BVPDT
736	Pyroflex	A		PTCHD
737	Resilon	A	175° max.	PTSD
740	Saran	F	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	A	180° max.	BIPTSCDF
800	Ace Hd. Rub.	A		BIVPTDF
801	Acidseal	A	All %; 150° max.	BIPTDF
805	Butyl	V		
809	Fairprene	V		
817	Heresite	A	Sat.; 212° max.	
835	Perbunan	V		
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	X		

No.	Material	Rating	Exposure Conditions	Applications
843	GR-P (S)	X		
844	GR-I	V		
846	Saniprene	A	All %; 150° max.	BIPTDF
848	Silastic	F	ASTM D-543-43	
849	Superflex	A	All %; 150° max.	BIPTDF
853	Thiokol	X		
854	Thiokol	F	150° max.	PTSCDF
856	Vistanex	V		

CARBON TETRACHLORIDE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A	Dry	
		V	Moist	
4	Admiralty	A	Dry	CH
		F	Moist	
6	Adnic	A		
10–17	Aluminum	AF	Rm.	BIPTC
19	Alloyco	A	Boil	BT
22	Ambraloy	A	Dry	CH
		F	Moist	
23	Ambraloy	A	Dry	CH
		F	Moist	
24	Ambraloy	A	Dry	CH
		F	Moist	
29–40	Ampco	A		BIVPTCHDF
51	Berylco	A		
54	Brass	A	Dry	CH
		V	Moist	
61	Brass	A	Dry	VCH
		V	Moist	
63	Brass	A	Dry	PCH
		FV	Moist	
66	Bronze	A	Dry	
		V	Moist	
73	Bronze	A	Dry	VT
		F	Moist	
74	Bronze	A	Dry	V
		F	Moist	
75	Bronze	A	Dry	VP
		F	Moist	
76	Bronze	A	Dry	Instruments
		F	Moist	
77	Bronze	A	Dry	PCH
		V	Moist	
85	Cast Iron	A		
86	Cast Iron	V		
87	Causul	A	Hot or cold	B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	A	Dry	
		V	Moist	
114	Copper	A	Dry	PTCHF
		F	Moist	
118	Copper	A	Dry	
		V	Moist	
123	Cupro-Ni	A	Dry	CH
		F	Moist	
124	Cupro-Ni	A	Dry	
		V	Moist	
127–133	Dowmetal	A	Dry	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % and temp.	BIVHF
142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A	Dry	BIVR
		F	Moist	
149	Everdur	A	Dry	PTCHDR
		F	Moist	
150	Everdur	A	Dry	PCH
		F	Moist	
159	Hastelloy	A	Any temp.	
160	Hastelloy	A	Any temp.	
161	Hastelloy	A	Any temp.	
162	Hastelloy	A	Any temp.	V
163	Stellite	A	Any temp.	
165	Stellite	A	Any temp.	
184	Inconel	A	Boil.	
185	Inc-Clad	A	Pure	BTSCH
216	Monel	A	Boil.	BIVPTCHDF
217	Monel-Clad	A	Pure	BTSCH
219	Muntz	A	Dry	CH
		V	Moist	
224	Nickel	A	Boil.	TCH
225	Ni-Clad	A	Pure	BTSCH
226	Nick-Sil.	A	Dry	Instruments
		X	Moist	
231	Ni-Resist	A	Boil.	BIV
233	NS-5	A	Any temp.	V
234	Olympic	A	Dry	
		V	Moist	
235	Olympic	A	Dry	
		V	Moist	
245	Pyrasteel	V		BIVPTSCHF
268	Silver	A	All temp.	
270	304-Clad	A	Pure; 70°	BTSCH
271	316-Clad	A	Pure; 70°	BTSCH
274	430-Clad	A	Pure; 70°	BTSCH
275	St. 301	V		
276	St. 302	V		
		A	Anhydrous; 70°; boil.	
		X	5%; 10%; 70°; aqueous sol.	
		A	Pure; 70°	
278	St. 303	V		
279	St. 304	V		
		X	5%; 10%; 70°; aqueous sol.	
		A	Pure; 70°	VTSCDF
280	St. 308	V		
281	St. 309	V		
282	St. 310	V		
283	St. 316	A		BIVPTS
		A	Anhydrous; 70°	
		A	Pure; 70°	VTCHDF
284	St. 317	A		VP
285	St. 321	V		
286	St. 347	V		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
		A	Anhydrous; 70°	
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	F		
		A	Anhydrous; 70°	
		A	Pure; 70°	VTSCHDF
296	St. 430-F	F		
297	St. 431	F		
298	St. 440-A	F		
300	St. 440-C	F		
301	St. 442	F		
303	St. 446	F		
308	St. CB-30	A	Boil.	
309	St. CC-35	A		
367	Super-Ni	A	Dry	PTCH
		F	Moist	
368	Tantalum	A		Not used commer.
369	Telnic	A	Dry	
		V	Moist	
390	Worthite	A	50%; 184°	BIV
401	Karbate	A	All %; to boil	BIV
402	Karbate	A	All %; to boil	BIV
403	Kemprul	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	X		
501	Sul. cement	X		
502	Furan cement	A	350° max.	PT
503	Furan cement	A	350° max.	PT
504	Phen. cement	A	300° max.	PT
505	Phen. cement	A	300° max.	PT
506	Silicate cemen	F	1,600° max.	T
507	Silicate cement	F	1,600° max.	T
508	Acichlor	X		
510	Acitite	F	Dilute and conc.; 250°	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	X		
518	C-Basoit	X		
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	X		
535	Nukem	A		T
536	Nukem	A		T
537	Pecomastic	X		
538	Penchlor	A	All %; 750° max.	

No.	Material	Rating	Exposure Conditions	Applications
539	Penchlo	A	All %; 750° max.	
540	Penchlor	A	All %; 500°–2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A		TD
544	Plastite	X		
545	P-Basolit	X		
554	Silastic	X	ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	F	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDFR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	Under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
700	Ace Saran	A		P
703	Compar	A	−40° to boil.	TD
704	DC Silicone	X	ASTM D-543-43	
706	Formica	A	Commercial	TD
707	Formica	A	All %; 212° max.	
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	X		
720	Lamicoid	A		
723	Nixon	A	C. P.; 77°	S
724	Nixon	A	77°	S
725	Nixon	X		
726	Nukemite	X		
733	Permanite	A	300° max.	BVPDT
735	Polythene	F	Rm.; swells slightly	
		X	176°	
736	Pyroflex	V		PTCHD
737	Resilon	X		
738	Resistoflex	A	Conc.; to boil	P
739	Resistoflex	A	Conc.; 275° max.	IVP
740	Saran	F	77°	
741	Sealon	V	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	X		
800	Ace Hd. Rub.	X		
801	Acidseal	X		
802	Acidseal	X		
805	Butyl	X		
809	Fairprene	X		
817	Heresite	X		
835	Perbunan	X		
836	Natural (S)	X		
837	Natural (H)	X		
838	GR-S (S)	X		
839	GR-S (H)	X		
840	GR-A (S)	X		
841	GR-A (H)	X		
842	GR-M (S)	X		
843	GR-P (S)	V		
844	GR-I	X		
846	Saniprene	X		
848	Silastic	X		
849	Superflex	X		
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	X		
856	Vistanex	X		

CHLORINE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A	Dry	
		V	Moist	
4	Admiralty	A	Dry	CH
		V	Moist	
6	Adnic	A	Dry gas	
10–17	Aluminum	X		
22	Ambraloy	A	Dry	CH
		V	Moist	
23	Ambraloy	A	Dry	CH
		V	Moist	
24	Ambraloy	A	Dry	CH
		V	Moist	
29-40	Ampco	F	Dry gas	BIVPTCHDF
54	Brass	A	Dry	CH
		X	Moist	
61	Brass	A	Dry	VCH
		X	Moist	
63	Brass	A	Dry	PCH
		V	Moist	
66	Bronze	A	Dry	
		V	Moist	
73	Bronze	A	Dry	VT
		V	Moist	
74	Bronze	A	Dry	V
		V	Moist	
75	Bronze	A	Dry	VP
		V	Moist	
76	Bronze	A	Dry	Instruments
		V	Moist	
77	Bronze	A	Dry	PCH
		X	Moist	
81	CA-FA20	A	Dry gas; 70°	BIVP
82	CA-MM	A	Dry gas; 70°	BIVP
86	Cast iron	A	Dry	
88	Chlorimet	A	Dry to 1,000°	BIVCHF
		X	Wet	
89	Chlorimet	A	Dry; all % to 950°	BIVCHF
		A	Wet; all % at rm.	BIVCF
111	Copper	A	Dry	
		V	Moist	
114	Copper	A	Dry	PTCHR
		V	Moist	
118	Copper	A	Dry	
		V	Moist	
123	Cupro-Ni	A	Dry	CH
		V	Moist	
124	Cupro-Ni	A	Dry	
		V	Moist	
139	Durco	A	Dry to 600°	BIVCHF
140	Durichlor	A	Wet; all %; rm.	BIVPCHFR
141	Durimet	A	Dry to 500°	BIVHF
142	Durimet	A	Dry to 500°	BIVHF
143	Duriron	X		
148	Everdur	A	Dry	BIVR
		V	Moist	
149	Everdur	A	Dry	PTCHDR
		V	Moist	
150	Everdur	A	Dry	PCH
		V	Moist	
184	Inconel	A	Dry; to 1,000°	
		X	Wet	
216	Monel	A	Dry; to 800°	BVPTSH
		X	Wet	
217	Monel-Clad	A	Dry gas	BTSCH
219	Muntz	A	Dry	CH
		X	Moist	
224	Nickel	A	Dry; to 1,000°	VTHD
		X	Wet	
225	Ni-Clad	A	Dry gas	BTSCH
226	Nick-Sil	A	Dry	Instruments
		V	Moist	
231	Ni-Resist	X	Wet	
234	Olympic	A	Dry	
		V	Moist	
235	Olympic	A	Dry	
		V	Moist	
240	Platinum	A	480° max.	
242	Ir-Plat.	A	480° max.	
244	Rh-Plat.	A	480° max.	
268	Silver	F	Rm.	
271	316-Clad	A	Dry gas; 70°	BTSCH
275	St. 301	X		
276	St. 302	X		
		A	Gas, dry; 70°	
		F	Gas, moist; 70°	
		X	Gas, moist; 212°	
		X	Chlorinated water; sat.; 70°	
		X	Gas, dry; 70°	
278	St. 303	X		
279	St. 304	X		
		X	Chlorinated water; sat.; 70°	
		X	Gas, dry; 70°	
280	St. 308	X		
281	St. 309	X		

No.	Material	Rating	Exposure Conditions	Applications
282	St. 310	X		
283	St. 316	X		
		A	Gas, dry; 70°	
		F	Gas, moist; 70°	
		X	Gas, moist; 212°	
		X	Chlorinated water; sat.; 70°	
		V	Gas, dry; 70°	VTCHDF
284	St. 317	X		
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
		X	Dry gas; 70°	
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
		F	Gas, dry; 70°	
		F	Gas, moist; 70°	
		X	Gas, moist; 212°	
		X	Chlorinated water; sat.; 70°	
		X	Gas, dry; 70°	
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
364	Stoody	A	Sat. vapor	
365	Stoody	F	Sat. vapo	
367	Super-Ni	A	Dry	PTCH
		F	Moist	
368	Tantalum	A	302° max.; wet or dry	CH
369	Telnic	A	Dry	
		V	Moist	
390	Worthite	X	Wet	
392	Wyndaloy	V	Aqueous sol.; 68°	
401	Karbate	A	All %; dry; 338° max.	
		V	Moist	P
402	Karbate	A	All %; dry; 338° max.	
		V	Moist	P
403	Kempruf	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	A	200° max.	PT
501	Sul. cement	A	200° max.	PT
502	Furan cem.	A	380° max.	PT
503	Furan cem.	A	360° max.	PT
504	Phen. cem.	A	300° max.	PT
505	Phen. cem.	A	380° max.	PT
506	Silicate cem.	F	1,600° max.	T
507	Silicate cem.	A	1,600° max.	PT
513	Asplit	X		
514	Asplit-F	X		
515	Basolit	A		T
517	Carboline	A		
518	C-Basolit	A		T
521	Causplit	X		
523	Duralon	V	350° max.	BIPTCHDF
524	Durisite	V	350° max.	BIPTCHDF
535	Nukem	X		
536	Nukem	A		T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°–2,000°	
541	Pennsalt	X		
542	Permanite	V		TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A		T
554	Silastic	X	ASTM D-543-43	
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIVPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
314	Glass-L	V		BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	V	1,000° max.	
619	Vitreosil	A		PH

No.	Material	Rating	Exposure Conditions	Applications
621	Vycor	A		
700	Ace Saran	X	Liquid	
703	Compar	X		
704	DC Silicone	X		
711	Haveg	A	All conditions	BIVPTDFR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	70° max.	
716	Heresite	A	70° max.	
720	Lamicoid	A		
726	Nukemite	A		PTSDF
733	Permanite	V	360° max.	BVPDT
736	Pyroflex	V		PTCHD
737	Resilon	A	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	X	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	F	180° max.	BIPTSCDF
801	Acidseal	A	Sat.; 1 atm. p.s.i.; 150° max. (wet only)	BIPTDF
805	Butyl	X		
809	Fairprene	X		
817	Heresite	V	Sat.; 212° max.	
835	Perbunan	X		
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	X		
844	GR-I	V		
846	Saniprene	A	Sat.; 1 atm. p.s.i.; 150° max. (wet only)	BIPTDF
848	Silastic	X		
849	Superflex	A	Sat.; 1 atm. p.s.i.; 150° max. (wet only)	BIPTDF
853	Thiokol	X		
854	Thiokol	F	150° max.	PTSCDF
856	Vistanex	X		

CHROMIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty			
4	Admiralty	X		
6	Adnic	X	Severe attack	
10–17	Aluminum	F	10% max.; Rm.	
22	Ambraloy	X		
23	Ambraloy	X		
24	Ambraloy	X		
29–40	Ampco	X		
54	Brass	X		
61	Brass	X		
63	Brass	X		
66	Bronze	X		
73	Bronze	X		
74	Bronze	X		
75	Bronze	X		
76	Bronze	X		
77	Bronze	X		
86	Cast iron	V		
88	Chlorimet	X		
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	X		
114	Copper	X		
118	Copper	X		
123	Cupro-Ni	X		
124	Cupro-Ni	X		
127–133	Dowmetal	A	C.P.	
		V	Technical; all %	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % and temp.	BIVHF
142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	X		
149	Everdur	X		
150	Everdur	X		
159	Hastelloy	X	All % and temp.	
160	Hastelloy	X	All % and temp.	
161	Hastelloy	A	All % to 160°	BIVPCH

No	Material	Rating	Exposure Conditions	Applications
162	Hastelloy	X	All % and temp.	
163	Stellite	A	All % and temp.	BIV
165	Stellite	F		
184	Inconel	A	5%; 86°	
191, 193	Lead	A	Sat.; to boil.; aerated; agitated; commercial purity	PTH
216	Monel	A	5%; 86°	VPTD
		X	Sat. aqueous sol.; 250°	
217	Monel-Clad	A		BTSCH
219	Muntz	X		
224	Nickel	A	5%; 86°	
225	Ni-Clad	A		BTSCH
226	Nick-Sil	X		
231	Ni-Resist	A	5%; 86°	BIV
234	Olympic	X		
235	Olympic	X		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
245	Pyrasteel	A		BIVPTSCHF
270	304-Clad	A	5%; 70°	BTSCH
271	316-Clad	A	10%; C.P.; boil.	BTSCH
274	430-Clad	A	5%	BTSCH
275	St. 301	X		
276	St. 302	X		
		X	50%; not C.P., contains SO_2; boiling	
		A	50%; not C.P., contains SO_2; 70°	
		A	10%; C.P., free of SO_2; 70°; boil.	
		A	50%; C.P., free of SO_2; 70°	
		F	50%; C.P., free of SO_2; boil.	
		A	5%; 70°	VTSCDF
		X	10% C.P.; boil.	
278	St. 303	X		
279	St. 304	X		
		A	5%; 70°	VTSCDF
		X	10%; C.P.; boil.	
280	St. 308	X		
281	St. 309	X		
282	St. 310	X		
283	St. 316	X		
		X	50%; not C.P., contains SO_2; boil.	
		A	50%; not C.P., contains SO_2; 70°	
		A	10%; C.P., free of SO_2; 70°; boil.	
		A	50%; C.P., free of SO_2; 70°	
		X	50%; C.P., free of SO_2; boil.	
		A	5%; 70°	VTCHDF
		A	10%; C.P.; boil.	VTCHDF
284	St. 317	X		
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
		X	50%; not C.P., contains SO_2; boil.	
		A	5%; 70°	VTSCHDF
		X	10%; C.P.; boil.	
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
367	Super-Ni	X		
368	Tantalum	A		Not used commer.
369	Telnic	X		
390	Worthite	A	Plating so.; anodizing sol.; 150°	BIVP
401	Karbate	X		
402	Karbate	X		
403	Kempruf	X		
404	Acheson	X		
500	Sul. cement	X		
501	Sul. cement	X		
502	Furan cem.	X		
503	Furan cem.	X		
504	Phen. cem.	X		
505	Phen. cem.	X		
506	Silicate cem.	A	1,600° max.	PT
507	Silicate cem.	A	1,600° max.	PT
508	Acichlor	F	Dilute and conc.; 300°	
510	Acitite	F	Dilute and conc.; 250°	
513	Asplit	X		
514	Asplit-F	X		
515	Basolit	A	Rm.	T
518	C-Basolit	A	Rm.	T
521	Causplit	X		
523	Duralon	X		
524	Durisite	X		
532	Lumnite	A	10% max.; 90°	
535	Nukem	X		
536	Nukem	A		T
537	Pecomastic	A		
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°–2,000°	
541	Pennsalt	X		
542	Permanite	X		
544	Plastite	F	175° max.	TDSP
545	P-Basolit	A	Rm.	T
556	Staminite	F	Cold	T
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	V		PTCH
610	Stoneware	A	All %; any temp.	BIVPCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	All %; under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
703	Compar	X		
704	DC Silicone	A	ASTM D-543-43	HD
711	Haveg	X		
713	Haveg	X		
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	F	35% max.; 130° max.	TD
720	Lamicoid	A		
726	Nukemite	A	Rm.	PTSDF
727	Nylon	X	Conc.	
728	Nylon	X	Conc.	
729–732	Nylon	X	Conc.	
733	Permanite	X		
736	Pyroflex	V		PTCHD
737	Resilon	F	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
744	Textolite	X	Conc.; 77°–122°	BI
745	Textolite	X	Conc.; 77°–122°	BI
746	Tygon	A	180° max.	BIPTSCDF
800	Ace Hd. Rub.	X		
805	Butyl	F	20%; 140° max.	
809	Fairprene	X		
817	Heresite	X		
836	Natural (S)	X		
837	Natural (H)	V		
838	GR-S (S)	X		
839	GR-S (H)	V		
840	GR-A (S)	X		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	X		
844	GR-I	A		
848	Silastic	A	ASTM D-543-43	
853	Thiokol	X		
854	Thiokol	F	150° max.	PTSCDF
856	Vistanex	F	20%; 140° max.	

FATTY ACIDS

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	A		CH
6	Adnic	A		

No	Material	Rating	Exposure Conditions	Applications
10–17	Aluminum	A	Rm., boil.; moisture inhibits attack	PTCH
19	Alloyco	A	150°–550°	BT
22	Ambraloy	A		CH
23	Ambraloy	A		CH
24	Ambraloy	A		CH
29–40	Ampco	AF	Depends on type and presence of oxygen	BIVPTCHDF
54	Brass	F		CH
61	Brass	F		VCH
63	Brass	A		PCH
66	Bronze	A		
73	Bronze	A		VT
74	Bronze	A		V
75	Bronze	A		VP
76	Bronze	A		Instruments
77	Bronze	F		PCH
87	Causul	A	Hot or cold	B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	A		
114	Copper	A		PTCHR
117	Copper	V		P
118	Copper	A		
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % and temp.	BIVHF
142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A		BIVR
149	Everdur	A		PTCHDR
150	Everdur	A		PCH
156	Gold	A		
159	Hastelloy	A	All % and temp.	BIVPTCH
160	Hastelloy	A	All % and temp.	BIVPTCH
161	Hastelloy	A	All % and temp.	BIVPTCH
162	Hastelloy	A	All % and temp.	BIVP
163	Stellite	A	All % and temp.	BIV
165	Stellite	A	All % and temp.	BIV
184	Inconel	A	Boil.	BIVPTCHR
185	Inc-Clad	A		BTSCH
196, 200, 266	Lead	V	212° max. in absence of oxygen	PTH
216	Monel	A	Boil.	BIVPTCH
217	Monel-Clad	A		BTSCH
219	Muntz	F		CH
224	Nickel	A	Boil.	PTH
225	Ni-Clad	A		BTSCH
226	Nick-Sil.	A		Instruments
231	Ni-Resist	A	Boil.	BIVPH
234	Olympic	A		
235	Olympic	A		
236	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
268	Silver	A		
275	St. 301	A		BIVTSCDF
276	St. 302	A		BIVTSCDF
278	St. 303	A		IVF
280	St. 308	A		BIVPTSCDF
281	St. 309	A		BIVTSCDF
282	St. 310	A		BIVPTSCHDF
283	St. 316	A		BIVPTSCHDF
284	St. 317	A		BIVPTSCHDF
285	St. 321	A		BIVPTSCH
286	St. 347	A		BIVPTSCDF
287	St. 403	A		IV
288	St. 405	A		BIVTSC
290	St. 410	A		BIVPTSCHDF
291	St. 414	A		IV
292	St. 416	A		IV
293	St. 418	A		
294	St. 420	A		
295	St. 430	A		BIVPTSCHDF
296	St. 430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSC
303	St. 446	A		BIVPTSC
313	St. CF-7	A	Boil.	
319	St. CF-7M	A	Boil.	

No.	Material	Rating	Exposure Conditions	Applications
367	Super-Ni	A		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	A		
390	Worthite	A	All %; any temp.	BIV
392	Wyndaloy	AV	68°	
401	Karbate	A	All %; to boil.	BIVPTCHDF
402	Karbate	A	All %; to boil.	BIVPTCHDF
403	Kempruf	A	All %; any temp.	PTDR
404	Acheson	A	All %; any temp.	PTDR
500	Sul. cement	F	100° max.	T
501	Sul. cement	F	100° max.	T
502	Furan cem.	A	360° max.	PT
503	Furan cem.	A	360° max.	PT
504	Phen. cem.	A	360° max.	PT
505	Phen. cem.	A	360° max.	PT
506	Silicate cem.	F	1,600° max.	T
507	Silicate cem.	F	1,600° max.	T
515	Basolit	A	200° max.	T
517	Carboline	A		
518	C-Basolit	A	200° max.	T
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
532	Lumnite	A	1% max.; 90°	TD
535	Nukem	A	350° max.	T
536	Nukem	A		T
542	Permanite	A		TD
544	Plastite	F	175° max.	TPSD
545	P-Basolit	A	200° max.	T
554	Silastic	A	ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	A	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	Under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	A	122°	P
703	Compar	A	200° max.	TD
704	DC Silicone	A	ASTM D-543-43	HD
706	Formica	A	All %; 212° max.	
711	Haveg	A	All conditions	BIVPTDFR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	F	All %; 100° max.	TD
720	Lamicoid	A		
726	Nukemite	V		PTSDF
733	Permanite	A	360° max.	BVPDT
736	Pyroflex	V		PTCHD
737	Resilon	F	175° max.	PTSD
738	Resistoflex	A	Conc.; 275° max.	P
739	Resistoflex	A	Conc.; 140° max.	IVP
741	Sealon	A	100° max.	BPTDF
742	Teflon	A	Rm.	VP
743	Textolite	A	Dil.; Rm.	T
744	Textolite	F	Dil.; Rm.	BI
745	Textolite	F	Dil.; Rm.	BT
746	Tygon	A	180° max.	BIPTSCDF
801	Acidseal	F	Any %; 100° max.	BIPTDF
805	Butyl	F	Rm.	
809	Fairprene	V		
814	GE Silicone	A	Dil. Rm.	VPTDF
817	Heresite	A	Sat.; 212° max.	
835	Perbunan	A	Rm.	
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	X		
844	GR-I	F		
846	Saniprene	F	Any %; 100° max.	BIPTDF
848	Silastic	A	ASTM D-543-43	
849	Superflex	F	Any %; 100° max.	BIPTDF

No.	Material	Rating	Exposure Conditions	Applications
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
856	Vistanex	F	Rm.	
913	Redwood	F	40°–220° max.; + 20% NaCl; soap plant	
		A	75% + Dil. H_2SO_4; 160° max.; reduction plant	
		A	75% + Dil. H_2SO_4 + Dil. NaOH; 160° max.; 10 yr	
		A	5%; 40°–185°; 32 yr.; Packing plant	

FERRIC CHLORIDE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	X		
4	Admiralty	X		
6	Adnic	X	Severe attack	
10–17	Aluminum	X		
22	Ambraloy	X		
23	Ambraloy	X		
24	Ambraloy	X		
29	Ampco	X		
42	Antaciron	A	Cold	
51	Berylco	X	Hot	
54	Brass	X		
61	Brass	X		
63	Brass	X		
66	Bronze	X		
73	Bronze	X		
74	Bronze	X		
75	Bronze	X		
76	Bronze	X		
77	Bronze	X		
88	Chlorimet	X		
89	Chlorimet	V	All % and temp.	BIVCHF
111	Copper	X		
114	Copper	X		
118	Copper	X		
119	Corrosiron	F	48%; Rm.; quiet; C. P	BIP
123	Cupro-Ni	X		
124	Cupro-Ni	X		
139	Durco	X		
140	Durichlor	V		BIVPCHFR
141	Durimet	X		
142	Durimet	X		
143	Duriron	V		
148	Everdur	X		
149	Everdur	X		
150	Everdur	X		
159	Hastelloy	X	All % and temp.	
160	Hastelloy	X	All % and temp.	
161	Hastelloy	A	10% to 160°	BIVPTCH
		A	45%; Rm. only	BIVPTCH
162	Hastelloy	X	All % and temp.	
163	Stellite	A	All %; Rm. only	BIV
165	Stellite	X	All % and temp.	
184	Inconel	X	10%; 70°	
216	Monel	X	10%; 70°	
219	Muntz	X		
224	Nickel	X	10%; 70°	
226	Nick-Sil.	X		
231	Ni-Resist	X	10%; 70°	
234	Olympic	X		
235	Olympic	X		
245	Pyrasteel	X		
268	Silver	F		
275	St. 301	X		
276	St. 302	X		
		X	Dil.; 70°	
278	St. 303	X		
279	St. 304	X		
280	St. 308	X		
281	St. 309	X		
282	St. 310	X		
283	St. 316	A		BIPT
		X	Dil.; 70°	
		X		
284	St. 317	A		PT
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
		X	Dil.; 70°	
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
		X	Dil.; 70°	
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
364	Stoody	A	10%; boil.; Rm.	
		A	25%; Rm.	
		F	25%; boil.	
365	Stoody	A	10%; Rm.	
		F	10%; boil.	
		F	25%; Rm.	
		X	25%; boil.	
367	Super-Ni	X		
368	Tantalum	A	200° max.	H
369	Telnic	X		
390	Worthite	X		
401	Karbate	A	All %; to boil.	BIVP
402	Karbate	A	All %; to boil.	BIVP
403	Kempruf	V		T
404	Acheson	V		T
500	Sul. cement	A	200° max.	PT
501	Sul. cement	A	200° max.	PT
502	Furan cement	A	360° max.	PT
503	Furan cement	A	360° max.	PT
504	Phen. cement	A	360° max.	PT
505	Phen. cement	A	360° max.	PT
506	Silicate cement	F	1,600° max.	T
507	Silicate cement	A	1,600° max.	PT
508	Acichlor	A	Dilute and conc.; 300°	
510	Acitite	X		
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	80%	T
517	Carboline	A		
518	C-Basolit	A	80%	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	A	25%; Rm.	BIVPTCDFR
535	Nukem	A	80%; 350° max.	T
536	Nukem	A	80%	T
537	Pecomastic	F	Dilute and conc.; 300°	
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500–2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	300° max.	TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A	80%	T
554	Silastic	A	ASTM D-543-43	
556	Staminite	F		T
559	Thiokol	A	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All %; any temp.	BIPTDR
614	Glass-L	A	All %; under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A	Concentrating solutions	
621	Vycor	A		
700	Ace Saran	A		P
704	DC Silicone	A		HD
711	Haveg	A	All conditions	BIVPTDFR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
720	Lamicoid	A		
726	Nukemite	A		PTSDF
733	Permanite	A	300° max.	BVPDT
736	Pyroflex	V		PTCHD
737	Resilon	A	175° max.	PTSD
740	Saran	F	77°	
741	Sealon	A	100° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	A	180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A		BIVPTDF

No.	Material	Rating	Exposure Conditions	Applications
801	Acidseal	A	All %; 150° max.	BIPTSDF
805	Butyl	A	Dry salt; aqueous sol.; Rm.	
809	Fairprene	A		
817	Heresite	A	Sat.; 212° max.	
835	Perbunan	A	Dry salt; aqueous sol.; Rm.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTSDF
848	Silastic	A	ASTM D-543-43	
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	A	All %; 150° max.	BIPTSDF
856	Vistanex	A	Dry salt; aqueous sol.; Rm.	
913	Redwood	F	20% + 5% HCl; 100-180°; 2 yr; smelter	T

HYDROCARBONS (ALIPHATIC)

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	A		CH
6	Adnic	A		
10-17	Aluminum	A		BIPTSCHDF
22	Ambraloy	A		CH
23	Ambraloy	A		CH
24	Ambraloy	A		CH
29-40	Ampco	A	Depends on halogen acid content	BIVPTCHDF
51	Berylco	A		
54	Brass	A		CH
61	Brass	A		VCH
63	Brass	A		PCH
66	Bronze	A		
67	Bronze	A		PIV
73	Bronze	A		VT
74	Bronze	A		V
75	Bronze	A		VP
76	Bronze	A		Instruments
77	Bronze	A		PCH
87	Causul	A		B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	A		
114	Copper	A		PTCHR
117	Copper	A		P
118	Copper	A		
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
127-133	Dowmetal	A	Dry	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A		BIVR
149	Everdur	A		PTCHDR
150	Everdur	A		PCH
156	Gold	A		
159	Hastelloy	A	All % and temp.	
160	Hastelloy	A	All % and temp.	
161	Hastelloy	A-	All % and temp.	BIVPTCH
162	Hastelloy	A	All % and temp.	
163	Stellite	A	All % and temp.	BIV
165	Stellite	A	All % and temp.	BIV
184	Inconel	A	Boil.	
216	Monel	A	Boil.	BVPTCH
219	Muntz	A		CH
224	Nickel	A	Boil.	
226	Nick-Sil.	A		Instruments
231	Ni-Resist	A	Boil.	BIVP
233	NS-5	A	If low in sulphur	
234	Olympic	A		
235	Olympic	A		
236	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
268	Silver	A		
275	St. 301	A		BIVTSCHDF
276	St. 302	A		BIVTSCDF
278	St. 303	A		IV
279	St. 304	A		BIVPTSCDF
280	St. 308	A		BIVPTSCDF
281	St. 309	A		BIVTSCDF
282	St. 310	A		BIVPTSCDF
283	St. 316	A		BIVPTSHD
284	St. 317	A		BIVPTSCDF
285	St. 321	A		BIVPTSCDF
286	St. 347	A		BIVPTSCDF
287	St. 403	A		IV
288	St. 405	A		BIVTSC
290	St. 410	A		BIVPTSCDF
291	St. 414	A		IV
292	St. 416	A		IV
293	St. 418	A		
294	St. 420	A		
295	St. 430	A		BIVPTSCDF
296	St. 430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSCH
303	St. 446	A		BIVPTSCDF
306	St. CA-15	A	High temp.	
350	St. HH	A	High temp.	
367	Super-Ni	A		PTCH
368	Tantalum	A	Good for catalytic & chlorination reactions in liquid phase	CH
369	Telnic	A		
401	Karbate	A	All %; 338° max.	BIVP
402	Karbate	A	All %; 338° max.	BIVP
403	Kemprul	A	All %; any temp.	T
404	Acheson	A	All %; any temp.	T
500	Sul. cement	X		
501	Sul. cement	X		
502	Furan cem.	A	360° max.	PTD
503	Furan cem.	A	300° max.	PTD
504	Phen. cem.	A	300° max.	PTD
505	Phen. cem.	A	300° max.	PTD
506	Silicate cem.	F	1,600° max.	PTD
507	Silicate cem.	F	1,600° max.	PTD
508	Acichlor	X		
510	Acitite	A	Dilute and conc.; 250°	
515	Basolit	X		
517	Carboline	A		
518	C-Basolit	X		
523	Duralon	A	300° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	V	Rm.	BIVPTCDFR
535	Nukem	A		T
536	Nukem	A		T
537	Pecomastic	X		
542	Permanite	A	360° max.	TD
544	Plastite	X		
545	P-Basolit	X		
554	Silastic	X	ASTM D-543-43	
559	Thiokol	A	150° max.	
600	Acid brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	Not commonly used	
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	Under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
700	Ace Saran	V		P
703	Compar	A	Conc.; −40° to 200°	TD
704	DC Silicone	V		HD
706	Formica	A	All %; 212° max.	ID
707	Formica	A	All %; 212° max.	I
708	Formica	A	Ordinary conditions; 122° max.	
711	Haveg	A	All conditions	BIVPTDFR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	V	All %; 100° max.	TD
720	Lamicoid	A		T
723	Nixon	F	77°	S
724	Nixon	A	77°	S

No.	Material	Rating	Exposure Conditions	Applications
725	Nixon	X	77°	
726	Nukemite	A		PTSDF
733	Permanite	A	360° max.	BVPTD
735	Polythene	F	Rm.; swells slightly	
		X	176°	
736	Pyroflex	V		PTCHD
737	Resilon	X		
738	Resistoflex	A	Conc.; −40° to 275°	P
739	Resistoflex	A	Conc.; −40° to 275°	PIV
741	Sealon	V	160° max.	BPTDF
742	Teflon	A	Rm.	VP
744	Textolite	A	77°–122°	BI
745	Textolite	A		BI
746	Tygon	V	180° max.	BIPTSCHDF
801	Acidseal	V	All %; 150° max.	BIPTSDF
805	Butyl	X		
809	Fairprene	A		
814	GE Silicone	V	Rm.	VPTDF
817	Heresite	A	Sat.; 86° max.	
835	Perbunan	A	To 300°; type hydrocarbon governs max. temp.	
836	Natural (S)	X		
837	Natural (H)	V		
838	GR-S (S)	X		
839	GR-S (H)	V		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	A		
844	GR-I	X		
846	Saniprene	V	All %; 150° max.	BIPTSDF
848	Silastic	X	ASTM D-543-43	
849	Superflex	V	All %; 150° max.	BIPTSDF
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
856	Vistanex	X		

HYDROCARBONS (AROMATIC)

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	A		CH
6	Adnic	A		
10–17	Aluminum	A		BIPTSCHDF
22	Ambraloy	A		CH
23	Ambraloy	A		CH
24	Ambraloy	A		CH
29–40	Ampco	A		BIVPTCHDF
54	Brass	A		CH
61	Brass	A		VCH
63	Brass	A		PCH
66	Bronze	A		
67	Bronze	A		PIV
73	Bronze	A		VT
74	Bronze	A		V
75	Bronze	A		VP
76	Bronze	A		Instruments
77	Bronze	A		PCH
87	Causul	A	Hot or cold	B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	A		
114	Copper	A		PTCHR
117	Copper	A		P
118	Copper	A		
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
127–133	Dowmetal	A	Dry	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A		BIVR
149	Everdur	A		PTCHDR
150	Everdur	A		PCH
156	Gold	A		
159	Hastelloy	A	All % and temp.	BIVPTCH
160	Hastelloy	A	All % and temp.	BIVPTCH
161	Hastelloy	A	All % and temp.	BIVPTCH
162	Hastelloy	A	All % and temp.	BIVP
163	Stellite	A	All % and temp.	BIV
165	Stellite	A	All % and temp.	BIV
184	Inconel	A	Boil.	
216	Monel	A	Boil.	BVPTCH
219	Muntz	A		CH
224	Nickel	A	Boil.	
226	Nick-Sil.	A		Instruments
231	Ni-Resist	A	Boil.	BIVP
233	NS-5	A	If low in sulphur	
234	Olympic	A		
235	Olympic	A		
236	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
268	Silver	A		
275	St. 301	A		BIVPTSCDF
276	St. 302	A		BIVTSCDF
278	St. 303	A		IV
279	St. 304	A		BIVPTSCDF
280	St. 308	A		BIVPTSCDF
281	St. 309	A		BIVTSCDF
282	St. 310	A		BIVPTSCDF
283	St. 316	A		BIVPTSHD
284	St. 317	A		BIVPTSCDF
285	St. 321	A		BIVPTSCDF
286	St. 347	A		BIVPTSCDF
287	St. 403	A		IV
288	St. 405	A		BIVTSC
290	St. 410	A		BIVPTSCHDF
291	St. 414	A		IV
292	St. 416	A		IV
293	St. 418	A		
294	St. 420	A		
295	St. 430	A		BIVPTSCDF
296	St. 430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSCH
303	St. 446	A		BIVPTSCDF
306	St. CA-15	A	High temp.	
350	St. HH	A	High temp.	
367	Super-Ni	A		PTCH
368	Tantalum	A	Good for catalytic and chlorination reactions in liquid phase	CH
369	Telnic	A		
401	Karbate	A	All %; 338° max.	BIVP
402	Karbate	A	All %; 338° max.	BIVP
403	Kempruf	A	All %; any temp.	T
404	Acheson	A	All %; any temp.	T
500	Sul. cement	X		
501	Sul. cement	X		
502	Furan cem.	A	360° max.	PTD
503	Furan cem.	A	300° max.	PTD
504	Phen. cem.	A	360° max.	PTD
505	Phen. cem.	A	300° max.	PTD
506	Silicate cem.	F	1,000° max.	TD
507	Silicate cem.	F	1,000° max.	TD
508	Acichlor	X		
510	Acitite	A	Dilute and conc.; 250°	
515	Basolit	X		
517	Carboline	A		
518	C-Basolit	X		
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	X		
535	Nukem	A		T
536	Nukem	A		T
537	Pecomastic	X		
542	Permanite	A	300° max.	TD
544	Plastite	X		
545	P-Basolit	X		
554	Silastic	X	ASTM D-543-43	
559	Thiokol	F	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
606	Stoneware	A	Not commonly used	
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	Under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
709	Ace Saran	V		

No.	Material	Rating	Exposure Conditions	Applications
703	Compar	A	Conc.; −40° to 200°	TD
704	DC Silicone	X		
706	Formica	A	All %; 212° max.	I
707	Formica	A	All %; 212° max.	I
708	Formica	A	Ordinary conditions; 122° max.	
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
718	Koroseal	X		
720	Lamicoid	A		T
723	Nixon	F	77°	S
724	Nixon	A	77°	S
725	Nixon	X		
726	Nukemite	X		
733	Permanite	A	390° max.	BVPTD
735	Polythene	V	Rm.; swells slightly	
		X	176°	
736	Pyroflex	V		PTCHD
737	Resilon	X		
738	Resistoflex	A	Conc.; −40° to 275°	P
739	Resistoflex	A	Conc.; −40° to 275°	IVP
741	Sealon	V	100° max.	BPTDF
742	Teflon	A	Rm.	VP
744	Textolite	A	77°–122°	BI
745	Textolite	A	77°–122°	BI
746	Tygon	X		
801	Acidseal	X		
802	Acidseal	X		
805	Butyl	X		
809	Fairprene	X		
814	GE Silicone	V	Rm.	VPTDF
817	Heresite	V	Sat.; 86°	
835	Perbunan	A	Type of hydrocarbon governs max. temp.	
836	Natural (S)	X		
837	Natural (H)	X		
838	GR-S (S)	X		
839	GR-S (H)	X		
840	GR-A (S)	X		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	A		
844	GR-I	X		
846	Saniprene	X		
848	Silastic	X	ASTM D-543-43	
849	Superflex	X		
853	Thiokol	F	150° max.	T
854	Thiokol	V	150° max.	PTSCDF
856	Vistanex	X		

HYDROCHLORIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	V		CH
6	Adnic	V		
10–17	Aluminum	X		
22	Ambraloy	V		CH
23	Ambraloy	V		CH
24	Ambraloy	V		CH
29–40	Ampco	V		BIVPTCHDF
42	Antaciron	A	All %; cold	PIV
51	Berylco	V		
54	Brass	X		
61	Brass	X		
63	Brass	V		PCH
66	Bronze	V		
73	Bronze	V		VT
74	Bronze	V		V
75	Bronze	V		VP
76	Bronze	V		
77	Bronze	X		
81	CA-FA20	A	1, 5% aerated and agitated; 70°	BIVP
		A	1%; boil.	BIVP
82	CA-MM	F	1, 5% aerated and agitated; 70°	BIVP
		X	1%; boil.	
87	Causul	F	Dil.; cold	
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % to 170°	BIVCHF
111	Copper	V		
114	Copper	V		PTCHR
118	Copper	V		
119	Corrosiron	F	5%; Rm.; unagitated; C. P.	BIPF
		V	25%; Rm.; unagitated; C. P.	BIPF
		V	37%; Rm.; unagitated; C. P.	BIPF
123	Cupro-Ni	V		CH
124	Cupro-Ni	V		
139	Durco	A	Dil.; Rm.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	Dil.; Rm.	BIVHF
143	Duriron	V	Low % and temp. (140 preferred)	BIVPHFR
148	Everdur	V		BIVR
149	Everdur	V		PTCHDR
150	Everdur	V		PCH
156	Gold	A	In absence of oxidizing material	
159	Hastelloy	A	All % to 160°	BIVPTSCHDF
160	Hastelloy	A	All % to boil.	BIVPTSCHDF
161	Hastelloy	A	All % to 125°	BIVPTCHDF
162	Hastelloy	A	All %; Rm. only	BIV
163	Stellite	A	All %; Rm. only	BIV
165	Stellite	X	All %; Rm.	
181	Hytensl	F	10% max.; cold	BIVHF
184	Inconel	X	0.5%; boil.	
		A	5% unaerated; 86°	
		F	5% aerated; 86°	
		X	5% unaerated; 158°	
		F	20% unaerated; 86°	
185	Inc-Clad	A	5% sol. sat. with N; 86°	BTSCH
216	Monel	A	0.5%; boil.	BIVPTCHDFR
		A	5% unaerated; 86, 158°	
		F	5% aerated; 86°	
		F	20% unaerated; 86°	
217	Monel-Clad	A	5% sol. sat. with N; 86°	BTSCH
219	Muntz	X		
224	Nickel	X	0.5%; boil.	
		A	5, 20% unaerated; 86°	BIVPTCH
		F	5% aerated; 86°	
		X	5% unaerated; 158°	
225	Ni-Clad	A	5% sol. sat. with N; 86°	BTSCH
226	Nick-Sil.	V		
231	Ni-Resist	A	5% unaerated; 86°	BIVR
		X	5% aerated; 86°	
		X	5% unaerated; 158°	
		F	20% unaerated; 86°	
233	NS-5	F	Low %; cold	V
234	Olympic	V		
235	Olympic	V		
236	Palladium	A	In absence of oxidizing material	
240	Platinum	A	In absence of oxidizing material	
242	Ir-Plat.	A	In absence of oxidizing material	
244	Rh-Plat.	A	In absence of oxidizing material	
245	Pyrasteel	X		
268	Silver	A	In absence of oxidizing material	
275	St. 301	X		
276	St. 302	X		
		X	Diluted 1:85; boil.	
		A	Diluted 1:85; 70°	
		F	Diluted 1:10; 70°	
		X	Diluted 1:10; boil.	
		A	Vapors; 70°	
		X	Vapors; 212°; 425°	
		X	All %; any temp.	
278	St. 303	X		
279	St. 304	X		
		X	All %; any temp.	
		X	1%; aerated and agitated; 70°	
		X	1%; boil.	
280	St. 308	X		
281	St. 309	X		
282	St. 310	X		
283	St. 316	X		
		A	Diluted 1:85; 70°	
		X	Diluted 1:85; boil.	
		A	Diluted 1:10; 70°	
		X	Diluted 1:10; boil.	
		A	Vapors; 70°	
		X	Vapors; 212°; 425°	
		X	All %; any temp.	
		A	1%; aerated and agitated; 70°	BIVP
		X	1%; boil.	
284	St. 317	X		
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
		X	Diluted 1:85; boil.	
		X	Diluted 1:10; boil.	
		X	1%; aerated and agitated; 70°	

No.	Material	Rating	Exposure Conditions	Applications
291	St. 414	X		
292	St. 416	X		
		X	All %	
293	St. 418	X		
294	St. 420	X		
		X	All %	
295	St. 430	X		
		X	Diluted 1:85; boil.	
		X	Diluted 1:10; boil.	
		X	All %; any temp.	
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		
364	Stoody	A	10%; Rm.	
		F	10%; boil.; conc.	
365	Stoody	F	10%; Rm.; boil.	
		X	Conc.; boil.	
367	Super-Ni	V		PTCH
368	Tantalum	A	662° max.	BPCH
369	Telnic	V		
387	Stainless	X	All %	
388	Stainless	X	All %	
389	Stainless	A	Weak	
		X	Strong	
390	Worthite	F	15%; 100°; without metal salts	
		X	20% min.	
392	Wyndaloy	V	Very dilute; 68°	
		X	Moderate dilution; 68°	
		X	Conc.; 68°	
401	Karbate	A	All %; to boil.	BIVPTCHD
402	Karbate	A	All %; to boil.	BIVPTCHD
403	Kemprul	A	All %; any temp.	PTDR
404	Acheson	A	All %; any temp.	PTDR
500	Sul. cement	A	200° max.	PTD
501	Sul. cement	A	200° max.	PTD
502	Furan cem.	A	360° max.	PTD
503	Furan cem.	A	300° max.	PTD
504	Phen. cem.	A	360° max.	PTD
505	Phen. cem.	A	300° max.	PTD
506	Silicate cem.	A	1,600° max.	PTD
507	Silicate cem.	A	1,600° max.	PTD
508	Acichlor	A	Dilute and conc. 300°	
510	Acitite	A	Dilute and conc. 250°	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	200° max.	T
517	Carboline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Duriaite	A	350° max.	BIPTCHDF
534	N-Series	V		BIVPTCDFR
		X	Conc.	
535	Nukem	A	350° max.	T
536	Nukem	A		T
537	Pecomastic	A	Dilute and conc.; 300°	
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°-2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	360° max.	TD
544	Plastite	A	60% max.; 175° max.	PTSD
545	P-Basolit	A	200° max.	T
554	Silastic	A	10%; ASTM D-543-43	
		X	Conc.; ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIPTVCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	All %; under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		PCH
621	Vycor	A		
700	Ace Saran	A		P
702	Compar	X		
704	DC Silicone	A		HD
706	Formica	F	All %; 212° max.	TD
711	Haveg	A	All conditions	BIVPTDFR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
716	Heresite	A	200° max.	
720	Lamicoid	X		
723	Nixon	X	10%; 77°	
724	Nixon	A	10%; 77°	
725	Nixon	A	10%; 77°	S
726	Nukemite	A	150° max.	PTSDF
727	Nylon	X	Conc.	
728	Nylon	X	Conc.	
729–732	Nylon	X		
733	Permanite	A	360° max.	BVPTD
735	Polythene	V	Rm.	
736	Pyroflex	A		PTCHD
737	Resilon	A	60% max.; 175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	A	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
743	Textolite	V		
744	Textolite	V		BI
745	Textolite	V		BI
746	Tygon	A	All %; 180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A		BIVPTDF
801	Acidseal	A	All %; 150° max.	BIPTSDF
805	Butyl	F	Rm.	
809	Fairprene	A		
814	G.E. Silicone	X		
817	Heresite	A	Conc.; 122° max.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	V		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTSDF
848	Silastic	A	10%; ASTM D-543-43	
		A	Conc.; ASTM D-543-43	
849	Superflex	A	All %; 150° max.	BIPTSDF
853	Thiokol	X		
854	Thiokol	F	150° max.	PTSCDF
855	Triflex	A	All %; 150° max.	BIPTSDF
856	Vistanex	F	Rm.	
913	Redwood	X	18-20° Be.; 60-120°; Failed in 3 mo.	T
		A	18° Be.; 60-120°; asphalt + tar-L; 12 yr.; chem. plant	T
		A	15%; 36-180°; 5 yr.; steel pickling	T
		F	5%; 36-90°; 3 yr.; Petroleum byproducts plant	T
		A	1½% + 2% H_2SO_4; 40-180°F; 21 yr.; chem. plant	T
		A	0.5% + Glycerine; 40-150°; 2 yr.; soap plant	T

HYDROFLUORIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	V		CH
6	Adnic	V		
10–17	Aluminum	X		
22	Ambraloy	V		CH
23	Ambraloy	V		CH
24	Ambraloy	V		CH
29–40	Ampco	A	18% max.; cold; anhydrous	BIVPTCHDF
54	Brass	X		
61	Brass	X		
63	Brass	V		PCH
66	Bronze	V		
73	Bronze	V		VT
74	Bronze	V		V
75	Bronze	V		VP
76	Bronze	V		
77	Bronze	X		

No.	Material	Rating	Exposure Conditions	Applications
81	CA-FA20	A	48%; 70°	BIVP
		X	48%; 176°	
82	CA-MM	A	48%; 70°	BIVP
		A	48%; 176°	BIVP
88	Chlorimet	A	All % at Rm.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVCHF
111	Copper	V		
114	Copper	V		PTCHR
118	Copper	V		
123	Cupro-Ni	V		CH
124	Cupro-Ni	V		
127-133	Dowmetal	A	Over 5%	
139	Durco	F	Low %; Rm	BIVHF
140	Durichlor	X		
141, 142	Durimet	F	Low %; Rm.	BIVHF
143	Duriron	X		
148	Everdur	V		BIVR
149	Everdur	V		PTCHDR
150	Everdur	V		PCH
156	Gold	A		
159	Hastelloy	A	All %; Rm. only	
160	Hastelloy	A	All % to boil.	
161	Hastelloy	A	All % to boil	
162	Hastelloy	X	All % to boil.	
163	Stellite	A	All %; Rm. only	BIV
165	Stellite	A	All %; Rm. only	BIV
181	Hytemal	A	50% max.; cold	BIVHF
184	Inconel	A	10%; 70°	
		X	6%; 170°	
		X	38%; 230°	
		A	100% to 900°	
216	Monel	A	10%; 70°	BIVPTCHDFR
		A	6%; 170°	
		A	38%; 230°	
		A	100%; to 1,100°	
217	Monel-Clad	A	60%; Rm.	BTSCH
219	Muntz	X		
224	Nickel	A	10%; 70°	VPTC
		X	6%; 170°	
		X	38%; 230°	
		A	100% to 1,2	
226	Nick-Sil.	V		
231	Ni-Resist	A	10%; 70°	BIVP
		X	6%; 170°	
		X	38%; 230°	
233	NS-S	A	Dil. or conc	V
234	Olympic	V		
235	Olympic	V		
236	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
245	Pyrasteel	X		
268	Silver	A		
275	St. 301	X		
276	St. 302	X		
		A	Vapors; 212°	
		X	All %; any temp.	
278	St. 303	X		
279	St. 304	X		
		X	All %; any temp.	
280	St. 308	X		
281	St. 309	X		
282	St. 310	X		
283	St. 316	X		
		A	Vapors; 212°	
		X	All %; any temp.	
284	St. 317	X		
285	St. 321	X		
286	St. 347	X		
287	St. 403	X		
288	St. 405	X		
290	St. 410	X		
291	St. 414	X		
292	St. 416	X		
293	St. 418	X		
294	St. 420	X		
295	St. 430	X		
296	St. 430-F	X		
297	St. 431	X		
298	St. 440-A	X		
300	St. 440-C	X		
301	St. 442	X		
303	St. 446	X		

No.	Material	Rating	Exposure Conditions	Applications
367	Super-Ni	F		PTCH
368	Tantalum	X		
369	Telnic	V		
390	Worthite	A	Cold, 0.5% in 4% H_3PO_4	BIV
		F	175°, 0.5% in 4% H_3PO_4	BIV
392	Wyndaloy	V	68°	
401	Karbate	A	60% max.; 185° max.	BIVPCHD
402	Karbate	A	60% max.; 185° max.	BIVPCHD
403	Kempruf	A	All %; to boil.	PTR
404	Acheson	A	All %; to boil.	PTR
503	Sul. cement	X		
501	Sul. cement	A	200° max.	PTD
502	Furan cem.	X		
503	Furan cem.	A	360° max.	PTD
504	Phen. cem.	X		
505	Phen. cem.	A	360° max.	PTD
506	Silicate cem.	X		
507	Silicate cem.	X		
513	Asplit	X		
514	Asplit-F	A	All %; 350° max.	
515	Basolit	X		
517	Carboline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	X		
523	Duralon	V	350° max.	BIPTCHDF
524	Durisite	V	350° max.	BIPTCHDF
535	Nukem	A	50% max.	T
536	Nukem	X		
538	Penchlor	X		
539	Penchlor	X		
540	Penchlor	X		
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	300° max.	TD
544	Plastite	V	175° max.	PTSD
545	P-Basolit	X		
556	Staminite	X		
559	Thiokol	X		
600	Acid Brick	X		
603, 612, 615	Glass	X	All % and temp.	
604	Ceratherm	X	All %	
606	Stoneware	X		
607	Glass-L	X		
610	Stoneware	X		
611	Porcelain	X		
614	Glass-L	X		
616	Pyrex	X		
617	Stoneware	A	All %	BIPTSCHDFR
618	Vitreo	X		
619	Vitreosil	X		
621	Vycor	X		
760	Ace Saran	A		P
703	Compar	X		
712	Haveg	A	All conditions	BIVPTDFR
714	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	20%; 70°	
716	Heresite	A	20%; 70°	
718	Koroseal	A	60%; 100°	TD
720	Lamicoid	X		
726	Nukemite	A	150° max.	PTSDF
727	Nylon	X	Conc.	
728	Nylon	X	Conc.	
729-732	Nylon	X		
733	Permanite	A	300° max.	BVPTD
735	Polythene	A	48%; Rm.	
736	Pyroflex	V		PTCHD
737	Resilon	V	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	A	77°	
741	Sealon	A	100° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	F	Dil.; 180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A		BIVPTDF
802	Acidseal	A	80% max.; 100°	BIPTSDF
805	Butyl	A		
809	Fairprene	A		
814	GE Silicone	X		
817	Heresite	A	48%; 77° max.	
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		

No.	Material	Rating	Exposure Conditions	Applications
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	V		
853	Thiokol	X		
854	Thiokol	F	150° max.	PTSCDF
856	Vistanex	A	Rm.	
913	Redwood	A	3½-5%; 36-90°; Pitch + asphalt-L; Airplane mfgr.	T
		A	3%; 36-90°; 5 yr.; steel plant	T

NITRIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	X		
4	Admiralty	X		
6	Adnic	X	Severe attack	
10–17	Aluminum	A	Over 80%	BIPTSCHDF
		FX	Under 80%	
22	Ambraloy	X		
23	Ambraloy	X		
24	Ambraloy	X		
29–40	Ampco	X		
51	Berylco	X		
54	Brass	X		
61	Brass	X		
63	Brass	X		
66	Bronze	X		
73	Bronze	X		
74	Bronze	X		
75	Bronze	X		
76	Bronze	X		
77	Bronze	X		
81	CA-FA20	A	65%; boil.	BIVP
82	CA-MM	X	65%; boil.	
88	Chlorimet	X		
89	Chlorimet	V		BIVHF
111	Copper	X		
114	Copper	X		
118	Copper	X		
119	Corrosiron	A	10, 25, 70%; Rm.; unagitated; C.P.	BIVPTCHDFR
123	Cupro-Ni	X		
124	Cupro-Ni	X		
139	Durco	V	All % (except strong) and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	X		
149	Everdur	X		
150	Everdur	X		
156	Gold	A	To boil.	
159	Hastelloy	X	All % and temp.	
160	Hastelloy	X	All % and temp.	
161	Hastelloy	A	All % to 150°	BIV
162	Hastelloy	X	All % and temp.	
163	Stellite	A	All % to 150°	BIV
165	Stellite	A	All % to 150°	BIV
184	Inconel	F	5%; 70°; aerated	
		A	65%; 70°	
216	Monel	X	5%; 70°; aerated	
219	Muntz	X		
224	Nickel	X	5%; 70°; aerated	
226	Nick-Sil.	X		
231	Ni-Resist	X	5%; 70°; aerated	
234	Olympic	X		
235	Olympic	X		
240	Platinum	A	To boil.	
242	Ir-Plat.	A	To boil.	
244	Rh-Plat.	A	To boil.	
245	Pyrasteel	V		
275	St 301	A	All %; Rm.	BIVTSCHDF
		A	65%; boil.	BIVTSCHDF
276	St. 302	A	All %; Rm.	BIVTSCHDF
		A	65%; boil.	BIVTSCHDF
		A	Diluted 1:10; 70°; boil.	
		A	Diluted 1:1; 70° boil.	
		A	Sp. gr. 1.40; conc.; 70°; boil.	
		A	Sp. gr. 1.52; conc.; fuming 70°; boil.	
		A	50% max.; boil.	VTSCDF
		A	65%; boil.	VTSCDF
		A	All %; 70°	VTSCDF
		X	Conc.; boil.	
		A	All %	
278	St. 303	A	All %; Rm.	IVF
		A	65%; boil.	IVF
279	St. 304	A	All %; Rm.	BIVPTSCHDF
		A	65%; boil.	BIVPTSCHDF
		A	50% max.; boil.	VTSCDF
		A	All %; 70°	VTSCDF
		X	Conc.; boil.	DF
		A	65%; boil.	BIVP
280	St. 308	A	All %; Rm.	BIVPTSCH
		A	65%; boil.	BIVPTSCH
281	St. 309	A	All %; Rm.	BIVTSCHDF
		A	65%; boil.	BIVTSCHDF
282	St. 310	A	All %; Rm.	BIVPTSCHDF
		A	65%; boil.	BIVPTSCHDF
283	St. 316	A	All %; Rm.	BIVPTSCHDF
		A	65%; boil.	BIVPTSCHDF
		A	Diluted 1:10; 70°; boil.	
		A	Diluted 1:1; 70°; boil.	
		A	Sp. gr. 1.40; conc.; 70°; boil.	
		A	Sp. gr. 1.52; conc. fuming; 70°	
		F	Sp. gr. 1.52; conc. fuming; boil.	
		A	50% max.; boil.	VTCHDF
		A	65%; boil.	VTCHDF
		A	All %; boil.	VTCHDF
		X	Conc.; boil.	
		F	65%; boil.	BIVP
284	St. 317	A	All %; Rm.	BIVPTSCHDF
		A	65%; boil.	
285	St. 321	A	All %; Rm.	BIVPTSCHDF
		A	65%; boil.	BIVPTSCHDF
286	St. 347	A	All %; Rm.	BIVPTSCHDF
		A	65%; boil.	BIVPTSCHDF
287	St. 403	V	All %; Rm.	
288	St. 405	V	All %; Rm.	
290	St. 410	V	All %; Rm.	
		A	Diluted 1:10; 70°	
		A	Diluted 1:1; 70°	
		A	All %	
		X	65%; boil.	
291	St. 414	V	All %; Rm.	
292	St. 416	V	All %; Rm.	
		A	All %	
293	St. 418	V	All %; Rm.	
294	St. 420	V	All %; Rm.	
		A	All %	
295	St. 430	V	All %; 70°	BIVPTSCHDF
		A	Diluted 1:10; 70°; boil.	
		A	Diluted 1:1; 70°; boil.	
		A	Sp. gr. 1.40; conc.; 70°	
		F	Sp. gr. 1.40; conc.; boil.	
		A	50% max.; boil.	VTSCHDF
		X	65%; boil.	
		A	All %; boil.	VTSCHDF
		X	Conc.; boil.	
		A	All %	
296	St. 430-F	V		
297	St. 431	V	Sp. gr. 1.42; all %; 70°	
		V	65%; boil.	
298	St. 440-A	V	Sp. gr. 1.42; all %; Rm.	
300	St. 440-C	V	Sp. gr. 1.42; all %; Rm.	
301	St. 442	V	Sp. gr. 1.42; all %; Rm.; 65%; boil.	BIVTSCH
303	St. 446	V	Sp. gr. 1.42; all %; Rm.; 65%; boil.	BIVPTSCHDF
313	St. CF-7	A	All %; boil.	
316	St. CF-20	A		BIV
319	St. CF-7M	A	All %	
364	Stoody	A	10%; boil.	
		F	Conc.; boil.	
365	Stoody	A	10%; boil.	
		F	Conc.; boil.	
367	Super-Ni	X		
368	Tantalum	A	All %; 392° max.	BCH
369	Telnic	V		
387	Stainless	A	All %	
388	Stainless	X	All %	
389	Stainless	A	All %	
390	Worthite	A	All %; 175°	BIV
392	Wyndaloy	V	Very dilute; 68°	
		X	Moderate dilution; 68°	
		X	Conc.; 68°	
401	Karbate	V	40% max.	BIVPTCH
402	Karbate	V	40% max.	BIVPTCH
403	Kemprut	V	40%; max.[7]	T
404	Acheson	V	40% max.	T
500	Sul. cement	A	30% max.; 200° max.	PTD

No.	Material	Rating	Exposure Conditions	Applications
501	Sul. cement	A	30% max.; 200° max.	PTD
502	Furan cem.	X		
503	Furan cem.	X		
504	Phen. com.	X		
505	Phen. com.	X		
506	Silicate cem.	A	1,600° max.	PTD
507	Silicate cem.	A	1,600 ° max.	PTD
508	Acichlor	F	Dilute and conc.; 300°	
510	Acitite	F	Dilute and conc.; 260°	
513	Asplit	X		
514	Asplit-F	X		
515	Basolit	A		T
518	C-Basolit	A		T
521	Causplit	X		
523	Duralon	X		
524	Durisite	X		
534	N-Series	X		
535	Nukem	X		
536	Nukem	A		T
537	Pecomastic	V	Dilute and conc.; 300°	
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°-2,000°	
541	Pennsalt	X		
542	Permanite	X		
544	Plastite	F	Dil.; 125° max.	PTSD
545	P-Basolit	A		T
554	Silastic	A	10%; ASTM D-543-43	
		X	Conc.; ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	/	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	All %; under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		PCH
621	Vycor	A		
700	Ace Saran	A	77°	P
703	Compar	X		
704	DC Silicone	A	10%	
707	Formica	F	5% max.; Rm.	
708	Formica	X	All %	
711	Haveg	V	5%; 125° max.	BIVPTDFR
715	Heresite	A	200° max.	
718	Karbanal	A	35% max.; 70° max.	TD
		A	10% max.; 150°	TD
720	Lamicoid	X		
723	Nixon	X	10%; 77°	
724	Nixon	A	10%; 77°	S
725	Nixon	A	10%; 77°	S
723	Permanite	X		
735	Polythene	X	Conc.; hot	
736	Pyroflex	V		PTCHD
737	Resilon	F	Dil.; 125° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	F	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
744, 745	Textolite	V		BI
746	Tygon	F	25% max.; 140° max.	BIPTSCHDF
800	Ace Hd. Rub.	A	16° Be; Rm.	BIVPTDF
801	Acidseal	A	20% max.; 70° max.	BIPTSDF
805	Butyl	V	35%; Rm.	
809	Fairprene	X		
814	GE Silicone	X	Conc.	VPTDF
817	Heresite	A	20% max.; 77° max.	
836	Natural (S)	X		
837	Natural (H)	V		
838	GR-S (S)	X		
839	GR-S (H)	V		
840	GR-A (S)	X		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	20% max.; 70° max.	BIPTSDF
848	Silastic	A	10%; ASTM D-543-43	
		A	Conc.; ASTM D-543-43	
849	Superflex	A	20% max.; 70° max.	BIPTSDF
853	Thiokol	X		
854	Thiokol	V	150° max.	PTSCDF
856	Vistanex	V	35%; Rm.	
913	Redwood	A	5-8% + Dil. H_2SO_4; asphalt-L; 21 yr.; explosives mfgr.	T
		A	1%; 40°-90°; Acid res. brick-L; chemical plant	T
		A	Very dil.; 70°-80°; 19 yr.; explosives mfgr.	T

OXALIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	A		CH
6	Adnic	A		
10-17	Aluminum	V		
		A	Dry powders	
22	Ambraloy	A		CH
23	Ambraloy	A		CH
24	Ambraloy	A		CH
29-40	Ampco	A		BIVPTCHDF
51	Berylco	A	Cold	
54	Brass	X		
61	Brass	X		
63	Brass	A		PCH
66	Bronze	A		
73	Bronze	A		VT
74	Bronze	A		V
75	Bronze	A		VP
76	Bronze	A		Instruments
77	Bronze	X		
86	Cast Iron	V		
89	Chlorimet	A		BIVHF
111	Copper	A		
114	Copper	A		PTCHR
117	Copper	V		P
118	Copper	A		
119	Corrosiron	A	2.1, 7.9%; Rm.; unagitated; C.P.	BIPF
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	A		BIVR
149	Everdur	A		PTCHDR
150	Everdur	A		PCH
156	Gold	A		
159	Hastelloy	A	All % and temp.	
160	Hastelloy	A	All % and temp.	
161	Hastelloy	A	All % and temp.	
162	Hastelloy	A	All % and temp.	
163	Stellite	A	All % and temp.	BIV
165	Stellite	A	All % and temp.	BIV
184	Inconel	A	20-50%; 100°-175°	
216	Monel	A	20-50%; 100°-175°	VPT
217	Monel-Clad	A	5%; any temp.	BTSCH
219	Muntz	X		
224	Nickel	F	20-50%; 100°-175°	
226	Nick-Sil.	A		Instruments
231	Ni-Resist	X	20-50%; 100°-175°	
234	Olympic	A		
235	Olympic	A		
238	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
270	304-Clad	A	10%; 70°	BTSCH
		A	5%; any temp.	BTSCH
271	316-Clad	A	10%; 70°	BTSCH
		A	5%; any temp.	BTSCH
274	430-Clad	A	5%; any temp.	BTSCH
275	St. 301	V		
276	St. 302	A	10%; 70°	
		F	10%; boil.	
		F	25%; boil.	
		F	50%; boil.	
		A	5%; any temp.	VTSCDF
		A	10%; 70°	VTSCDF
		X	10%; boil.	

No.	Material	Rating	Exposure Conditions	Applications
278	St. 303	V		
279	St. 304	V		
		A	5%; any temp.	VTSCDF
		A	10%; 70°	VTSCDF
		X	10%; boil.	
280	St. 308	V		
281	St. 309	V		
282	St. 310	V		
283	St. 316	V		
		A	10%; 70°	
		F	10%; boil.	
		F	25%; boil.	
		F	50%; boil.	
		A	5%; any temp.	VTCHDF
		A	10%; 70°	VTCHDF
		X	10%; boil.	
284	St. 317	V		
285	St. 321	V		
286	St. 347	V		
287	St. 403	V		
288	St. 405	V		
290	St. 410	V		
291	St. 414	V		
292	St. 416	V		
293	St. 418	V		
294	St. 420	V		
295	St. 430	V		
		A	5%; any temp.	VTSCHDF
		A	10%; 70°	VTSCHDF
		X	10%; boil.	
296	St. 430-F	V		
297	St. 431	V		
298	St. 440-A	V		
300	St 440-C	V		
301	St. 442	V		
303	St. 446	V		
319	St. CF-7M	A	10%; 212°	
367	Super-Ni	A		PTCH
368	Tantalum	A		Not used commer
369	Telnic	A		
390	Worthite	A	175°	BIV
401	Karbate	A	All %; to boil.	PS
402	Karbate	A	All %; to boil.	PS
403	Kempruf	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	A	200° max.	PT
501	Sul. cement	A	200° max.	PT
502	Furan cem.	A	360° max.	PT
503	Furan cem.	A	360° max.	PT
504	Phen. cem.	A	360° max.	PT
505	Phen. cem.	A	360° max.	PT
506	Silicate cem.	A	1,600° max.	PT
507	Silicate cem.	A	1,600° max.	PT
508	Acichlor	A	Dilute and conc.; 300°	
510	Acitite	A	Dilute and conc.; 250°	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	200° max.	T
517	Carboline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
535	Nukem	A	350° max.	T
536	Nukem	A		T
537	Pecomastic	X		
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°–2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	360° max.	TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A	200° max.	T
554	Silastic	A	ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	A	150° max.	
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	All %; 77° max.; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		
621	Vycor	A		
700	Ace Saran	A		P
704	DC Silicone	A		
706	Formica	A	All %; 122° max.	PT
707	Formica	V	All %	
708	Formica	F	All %; Rm.	
711	Haveg	A	All conditions	BIVPTDFR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
720	Lamicoid	A		T
726	Nukemite	A	150° max.	PTSDF
727	Nylon	A	Dilute	
728	Nylon	A	Dilute	
729-732	Nylon	X		
733	Permanite	A	360° max.	PVBTD
736	Pyroflex	V		PTCHD
737	Resilon	A	175° max.	PTSD
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
744, 745	Textolite	V		BI
746	Tygon	A	180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A		BIVPTDF
809	Fairprene	V		
814	GE Silicone	V	Rm.	VPTDF
817	Heresite	A	Sat.; 212°	
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	V		
843	GR-P (S)	X		
844	GR-I	V		
848	Silastic	A	ASTM D-543-43	
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF

PHENOL

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	F		CH
6	Adnic	A		
10-17	Aluminum	A	Rm.–212°; moisture inhibits action	VPFSCHD
22	Ambraloy	F		CH
23	Ambraloy	F		CH
24	Ambraloy	F		CH
29–40	Ampco	A	If contamination is no factor	BIVPTCHDF
54	Brass	F		CH
61	Brass	F		VCH
63	Brass	FV		PCH
66	Bronze	V		
73	Bronze	F		VT
74	Bronze	F		V
75	Bronze	F		VP
76	Bronze	F		
77	Bronze	F		PCH
85	Cast Iron	A	Conc.	
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVHF
111	Copper	V		
114	Copper	F		PTCHR
117	Copper	V		P
118	Copper	V		
123	Cupro-Ni	F		CH
124	Cupro-Ni	V		
127-133	Dowmetal	A	248°	
		X	356°	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	F		BIVR
149	Everdur	F		PTCHDR
150	Everdur	F		PCH
156	Gold	A		
159	Hastelloy	A	All % and temp.	
160	Hastelloy	A	All % and temp.	

No.	Material	Rating	Exposure Conditions	Applications
161	Hastelloy	A	All % and temp	
162	Hastelloy	A	All % and temp.	
163	Stellite	A	All % and temp.	BIV
165	Stellite	A	All % and temp.	BIV
184	Inconel	A	90%; boil.	PTCH
185	Inc-Clad	A	All %; any temp.	BTSCH
216	Monel	A	90%; boil.	VPT
217	Monel-Clad	A	All %; any temp.	BTSCH
219	Muntz	F		CH
224	Nickel	A	90%; boil.	BIVPTSCH
225	Ni-Clad	A	All %; any temp.	BTSCH
226	Nick-Sil.	F		Instruments
231	Ni-Resist	A	90%; boil.	BIVP
234	Olympic	V		
235	Olympic	V		
236	Palladium	A		
240	Platinum	A		
242	Ir-Plat.	A		
244	Rh-Plat.	A		
268	Silver	A		
270	304-Clad	A	All %; any temp.	BTSCH
271	316-Clad	A	All %; any temp.	BTSCH
275	St. 301	V		
276	St. 302	V		
		A	C.P.; boil.	
		A	Raw; boil.; 212°	
278	St. 303	V		
279	St. 304	V		
280	St. 308	V		
281	St. 309	V		
282	St. 310	V		
283	St. 316	A		VP
		A	C.P.; boil.	
		A	Raw; boil.; 212°	
284	St. 317	A		PT
285	St. 321	V		
286	St. 347	V		
287	St. 403	V		
288	St. 405	V		
290	St. 410	V		
291	St. 414	V		
292	St. 416	V		
293	St. 418	V		
294	St. 420	V		
295	St. 430	V		
296	St. 430-F	V		
297	St. 431	V		
298	St. 440-A	V		
300	St. 440-C	V		
301	St. 442	V		
303	St. 446	V		
306	St. CA-15	A	Conc.; boil.	
313	St. CF-7	A	Conc.; boil.	
367	Super-Ni	F		PTCH
368	Tantalum	A		Not used commer.
369	Telnic	V		
390	Worthite	A	370°	BIV
401	Karbate	A	All %; to boil.	PH
402	Karbate	A	All %; to boil.	PH
403	Kemprof	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	A	Dilute sol.; low temp. only	PT
501	Sul. cement	A	Dilute sol.; low temp. only	PT
502	Furan cem.	A	Phenol sol.; 220° max.	PT
503	Furan cem.	A	Phenol sol.; 220° max.	PT
504	Phen. cem.	A	Phenol sol.; 220° max.	PT
505	Phen. cem.	A	Phenol sol.; 220° max.	PT
506	Silicate cem.	A	1,600° max.	PT
507	Silicate cem.	A	1,600° max.	PT
513	Asplit	X		
514	Asplit-F	X		
515	Basolit	A	200° max.	T
517	Carbeline	A		
518	C-Basolit	A	200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	X	Above Rm.	
535	Nukem	A	350° max.	T
536	Nukem	A		T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°-2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	360° max.	TD
544	Plastite	F	175° max.	PTSD
545	P-Basolit	A	200° max.	T
554	Silastic	X	ASTM D-543-43	
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	Not commonly used	
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	Under 302°; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	A	Crystals; 77°	P
703	Compar	V		
704	DC Silicone	X		
713	Haveg	V	Satisfactory for water sol.	BIVPTDFR
715	Heresite	A	200° max.	
718	Koroseal	A		TD
720	Lamicoid	A		T
726	Nukemite	A	150° max.	PTSDF
727	Nylon	X		
728	Nylon	X		
729-732	Nylon	X		
733	Permanite	A	360° max.	PVBTD
736	Pyroflex	A		PTCHD
737	Resilon	F	175° max.	PTSD
738	Resistoflex	V		
739	Resistoflex	V		
740	Saran	F	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	V	180° max.	BIPTSCHDF
801	Acidseal	A		BIPTSDF
802	Acidseal	A		BIPTSDF
805	Butyl	A	Rm.	
809	Fairprene	F		
817	Heresite	A	Sat.; 122° max.	
835	Perbunan	F	Rm.	
836	Natural (S)	X		
837	Natural (H)	V		
838	GR-S (S)	X		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	X		
843	GR-P (S)	X		
844	GR-I	X		
846	Saniprene	A		BIPTSDF
848	Silastic	X	ASTM D-543-43	
849	Superflex	A		BIPTSDF
853	Thiokol	A		
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	A		
856	Vistanex	A	Rm.	

PHOSPHORIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	V		CH
6	Adnic	F	Attacked	
10-17	Aluminum	X		
19	Alloyco	A	25%; boil.	BV
		A	45%; 70°	BV
22	Ambraloy	V		CH
23	Ambraloy	V		CH
24	Ambraloy	V		CH
29-40	Ampco	F	Up to 85%; pure	BIVPTCHDF
54	Brass	X		
61	Brass	X		
63	Brass	V		PCH
66	Bronze	V		
73	Bronze	V		VT
74	Bronze	V		V
75	Bronze	V		VP
76	Bronze	V		
77	Bronze	X		
81	CA-FA20	A	85% aerated and agitated; 70°	BIVP
		A	85%; boil.	BIVP

No.	Material	Rating	Exposure Conditions	Applications
82	C MM	A	85% aerated and agitated; 70°	BIVP
		F	85%; boil.	BIVP
86	Cast Iron	V	Crude	
88	Chlorimet	A	All % to 170°	BIVCHF
89	Chlorimet	A	All % to 170°	BIVHF
111	Copper	V		
114	Copper	V		PTCHR
117	Copper	V	Dilute	P
118	Copper	V		
119	Corrosiron	A	10, 25, 87%; Rm.; unagitated; C.P.	BIVPF
123	Cupro-Ni	V		CH
124	Cupro-Ni	V		
139	Durco	A	All % and temp. except conc. boil.	BIVHF
140	Durichlor	A	All % and temp. (except crude)	BIVPCHFR
141, 142	Durimet	A	All % to 176°	BIVHF
143	Duriron	A	All % and temp. (except crude)	BIVPHFR
148	Everdur	V		BIVR
149	Everdur	V		PTCHDR
150	Everdur	V		PCH
156	Gold	A	All %; any temp.	
159	Hastelloy	A	All % to 180°	BIVPTCHDF
160	Hastelloy	A	All % to boil.	BIVPTCHDF
161	Hastelloy	A	All % to boil.	BIVPTCHDF
162	Hastelloy	A	All % to boil.	BIVP
163	Stellite	A	All % to boil.	BIV
165	Stellite	A	All % to boil.	BIV
181	Hytenal	A	10% max.; cold	BIVF
184	Inconel	A	12%; 212°; unaerated	
		A	57%; 70°	
		X	90%; 220°	
196, 200, 266	Lead	A	80% max.; 212° max.; 85% max. with crude	BIPTSCH
216	Monel	A	12%; 212°; unaerated	BIVPTCHDF
		A	57%; 70°	
		A	90%; 220°	
217	Monel-Clad	A	5% max.; 70°	BTSCH
219	Muntz	X		
224	Nickel	A	12%; 212°; unaerated	BVPT
		X	57%; 70°	
		F	90%; 220°	
225	Ni-Clad	A	5% max.; 70°	BTSCH
226	Nick-Sil.	V		
231	Ni-Resist	F	12%; 212°; unaerated	BIVP
		F	57%; 70°	
		X	90%; 220°	
234	Olympic	V		
235	Olympic	V		
240	Platinum	A	All %; any temp.	
242	Ir-Plat.	A	All %; any temp.	
244	Rh-Plat.	A	All %; any temp.	
245	Pyrasteel	V		
268	Silver	A	Under 365°	
		F	Over 365°	
270	304-Clad	A	Under 5%; 70°	BTSCH
271	316-Clad	A	10%	BTSCH
274	430-Clad	A	Under 5%; 70°	BTSCH
275	St. 301	A		BIVTSC
276	St. 302	A		BIVTSCH
		A	1%; 70°; boil.	
		A	1% at 45 lb. pressure; 275°	
		A	10%; boil.	
		A	45%; boil.	
		A	80%; 140°	
		X	80%; 230°	
		A	5%; max.; 70°	VTSCDF
		X	10%; 70°	
		A	Weak or medium	
		X	Boil.; strong	
		A	Cold; strong	
278	St. 303	A		IV
279	St. 304	A		BIVPTSCH
		A	5% max.; 70°	VTSCDF
		X	10%; 70°	
		A	85%; aerated and agitated; 70°	BIVP
280	St. 308	A		BIVPTSCH
281	St. 309	A		BIVTSCH
282	St. 310	A		BIVPTSC
283	St. 316	A		BIVPTSCH
		A	1%; 70°; boil.	
		A	1% at 45 lb. pressure; 275°	
		A	10%; boil.	
		A	45%; boil.	
		A	80%; 140°	
		F	80%; 230°	
		A	5% max.; 70°	VTCHDF
		A	10%; 70°	VTCHDF
		A	85%; aerated and agitated; 70°	BIVP
284	St. 317	A		BIVPTSCH
285	St. 321	A		BIVPTSCH
286	St. 347	A		BIVPTSCH
287	St. 403	V		
288	St. 405	V		
290	St. 410	V		
		A	1%; 70°	
		X	All %	
		A	85% aerated and agitated; 70°	BIVP
291	St. 414	V		
292	St. 416	V		
		X	All %	
293	St. 418	V		
294	St. 420	X	Medium and strong	
		V		
		A	Weak	
295	St. 430	V		
		A	1%; 70°	
		A	5% max.; 70°	VTSCHDF
		X	10%; 70°	
		X	All %	
296	St. 430-F	V		
297	St. 431	V		
298	St. 440-A	V		
300	St. 440-C	V		
301	St. 442	V		
303	St. 446	V		
309	St. CC-35	A	85%; 130°	
316	St. CF-20	A		BIV
367	Super-Ni	V		PTCH
368	Tantalum	V	All % (fluorine below 10 p.p.m.), to 392°	CH
369	Telnic	V		
387	Stainless	A	Weak	
		X	Medium and strong	
388	Stainless	X	All %	
389	Stainless	A	All %	
390	Worthite	A	5%; boil.	BIV
		A	70%; 175°; with slurry & HF to 0.5%	BIV
		A	85%; [illegible]°	BIV
392	Wyndaloy	A V	68°	
401	Karbate	A	85% max.; to boil.	BIVPTH
402	Karbate	A	85% max.; to boil.	BIVPTH
403	Kemprut	A	All %; any temp.	PTDR
404	Acheson	A	All %; any temp.	PTDR
500	Sul. cement	A	85% max.; 200° max.	PT
501	Sul. cement	A	85% max.; 200° max.	PT
502	Furan cem.	A	85% max.; 360° max.	PT
503	Furan cem.	A	85% max.; 360° max.	PT
504	Phen. cem.	A	85% max.; 360° max.	PT
505	Phen. cem.	A	85% max.; 360° max.	PT
506	Silicate cem.	A	85% max.; 1,600° max.	PT
507	Silicate cem.	A	85% max.; 1,600° max.	PT
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	70%	T
517	Carboline	A		
518	C-Basolit	A	70%	T
521	Causplit	A	All %; 350° max.	
523	Duralon	A	350° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
532	Lumnite	A	1% max.; 90° max.	TD
535	Nukem	A	70%; 350° max.	T
536	Nukem	A	70%	T
538	Penchlor	A	All %; 750° max.	
539	Penchlor	X		
540	Penchlor	X		
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	360° max.	TD
544	Plastite	A	175° max.	PTSD
545	P-Basolit	A	70%	T
554	Silastic	A	ASTM D-543-43	
556	Staminite	V	Cold	T
559	Thiokol	V	150° max.	
600	Acid Brick	A	Dil.; cold	TDR
		X	Conc.; hot	
603, 612, 615	Glass	V	Better at low % and temp.	THDR
684	Ceratherm	A	200°–400°, depending on design	BIPTSCHDFR

No.	Material	Rating	Exposure Conditions	Applications
606	Stoneware	F	Under 176°	
607	Glass-L	V		PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	V	Dil.; cold	BIPTDR
614	Glass-L	A	40% max.; 212° max.; agitation	BTCH
616	Pyrex	X	Glacial	
617	Stoneware	A	140-160°	BIPTSCHDFR
618	Vitreo	V	1,000° max.	
619	Vitreosil	V		
621	Vycor	X	Glacial	
700	Ace Saran	A		P
703	Compar	X		
704	DC Silicone	A		
707	Formica	F	All %; 122°	
711	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
718	Korosea1	X		
720	Lamicoid	A		T
726	Nukemite	A	150° max.	PTSDF
727	Nylon	X	Conc.	
728	Nylon	X	Conc.	
729-732	Nylon	X		
733	Permanite	A	300° max.	BVPTD
736	Pyroflex	A		PTCHD
737	Resilon	A	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	A	77°	
741	Sealon	A	100° max.	BPTDF
742	Teflon	A	Rm.	VP
744-745	Textolite	V		BI
746	Tygon	A	180°	BIPTSCHDF
800	Ace Hd. Rub.	A	85%	BIVPTDF
801	Acidseal	X		
802	Acidseal	X		
805	Butyl	A	85%; Rm.	
809	Fairprene	A		
814	GE Silicone	V		VPTDF
817	Heresite	A	Sat.; 104° max.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	X		
848	Silastic	A	ASTM D-543-43	
849	Superflex	X		
853	Thiokol	V	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	X		
856	Vistanex	A	85%; Rm.	
913	Redwood	V	30%; 36-90°; 1-3 yr.; Airplane mfgr.	T

SODIUM CHLORIDE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	A		
4	Admiralty	A		CH
6	Adnic	A		
10-17	Aluminum	AF	Rm.-boil.; Alclad alloys best	PTSCH
		A	Dry powders	
22	Ambraloy	A		CH
23	Ambraloy	A		CH
24	Ambraloy	A		CH
29-48	Ampco	A		
51	Berylco	A		
54	Brass	V		CH
61	Brass	V		VCH
63	Brass	AF		PCH
66	Bronze	A		
67	Bronze	A	Seawater	BIV
71	Bronze	A	Seawater	BIV
72	Bronze	A	Seawater	BIV
73	Bronze	F		VT
74	Bronze	F		V.
75	Bronze	A		VP
76	Bronze	F		
77	Bronze	V		PCH
85	Cast Iron	A		
86	Cast Iron	A		
87	Causal	A		B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVHF
111	Copper	A		
114	Copper	F		PTCHR
117	Copper	V		P
118	Copper	A		
119	Corrosiron	A	25%; Rm.; unagitated; C.P	BIVP
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVHF
143	Duriron	A	All % and temp. (140 preferred)	BIVPHFR
148	Everdur	F		BIVR
149	Everdur	F		PTCHDR
150	Everdur	F		PCH
157	Gun Metal	A	Seawater	BIV
159	Hastelloy	A	All % to boil.	
160	Hastelloy	A	All % to boil.	
161	Hastelloy	A	All % to boil.	BIVPH
162	Hastelloy	A	All % to boil.	
163	Stellite	A	All %; Rm.	BIV
165	Stellite	A	All %; Rm.	BIV
181	Hytenal	A		BIVHF
184	Inconel	A	Sat.; 200°	
185	Inc-Clad	A	Sat. sol. mixed with steam and air; 200°	BTSCH
193, 196, 200, 266	Lead	A	Dil. sol.; seawater; brine	BIPT
216	Monel	A	Sat.; 200°	BIVPTCHDF
217	Monel-Clad	A	Sat. sol. mixed with steam and air; 200°	BTSCH
219	Muntz	V		CH
224	Nickel	A	Sat.; 200°	BV
225	Ni-Clad	A	Sat. sol. mixed with steam and air; 200°	BTSCH
226	Nick-Sil.	A		Instruments
231	Ni-Resist	A	Sat.; 200°	BIVP
233	NS-5	A	All % and temp.	V
234	Olympic	A		
235	Olympic	A		
245	Pyrasteel	V		
249	Resistac	A		BIVCHF
270	304-Clad	A	Sat.; boil.	BTSCH
271	316-Clad	A	5%; 150°	BTSCH
274				
275	St. 301	V		
276	St 302	V		
		V	Cold saturated solution; 70°	
		A	Hot saturated at 212°	
		X	5%; 150°	
		X	Saturated; boil.	
278	St. 303	V		
279	St. 304	V		
		X	5%; 150°	
		X	Saturated; boil.	
280	St. 308	V		
281	St. 309	V		
282	St. 310	V		
283	St. 316	V		
		V	Cold saturated solution; 70°	
		A	Hot saturated at 212°	
		A	5%; 150°	VTCHDF
		A	Saturated; boil.	VTCHDF
284	St. 317	V		
285	St. 321	V		
286	St. 347	V		
287	St. 403	V		
288	St. 405	V		
290	St. 410	V		
291	St. 414	V		
292	St. 416	V		
293	St. 418	V		
294	St. 420	V		
295	St. 430	V		
		X	5%; 150°	
296	St. 430-F	V		
297	St. 431	V		
298	St. 440-A	V		
300	St. 440-C	V		
301	St. 442	V		
303	St. 446	V		
316	St. CF-20	A		BIV
367	Super-Ni	A		PTCH
368	Tantalum	V	Water sol. only; 212° max.	Not used commer.

No.	Material	Rating	Exposure Conditions	Applications
369	Telnic	A		
390	Worthite	A	All %; any temp.	BIV
392	Wyndaloy	AV	Moderate dilution; 68°; seawater and brines	
		AV	Conc.; 68°; seawater and brines	
401	Karbate	A	All %; to boil.	BIVPH
402	Karbate	A	All %; to boil.	BIVPH
403	Kempruf	A	All %; any temp.	
404	Acheson	A	All %; any temp.	
500	Sul. cement	A	200° max.	PTD
501	Sul. cement	A	200° max.	PTD
502	Furan cem.	A	360° max.	PTD
503	Furan cem.	A	380° max.	PTD
504	Phen. cem.	A	360° max.	PTD
505	Phen. cem.	A	300° max.	PTD
506	Silicate cem	X		
507	Silicate cem.	V	1,600° max.	TD
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Coratherm	A	200°–400°, depending on design	BIPTSCHDFR
606	Stoneware	A	Not commonly used	
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	All %; 302° max.; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°–160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
621	Vycor	A		
700	Ace Saran	A		P
704	DC Silicone	A		
706	Formica	A	All %; 212° max.	T
707	Formica	A	All %; 212° max.	
708	Formica	F	All conc.	
711	Haveg	A	All conditions	BIVPTFDR
713	Haveg	A	All conditions	BIVPTDFR
715	Heresite	A	200° max.	
718	Koroseal	A	Any %; 150° max.	TD
720	Lamicoid	A		T
723	Nixon	A	10%	S
724	Nixon	A	10%	S
726	Nukemite	A		PTSDF
733	Permanite	A	300° max.	PVBDT
736	Pyroflex	A		PTCHD
737	Resilon	A	175° max.	PTSD
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
746	Tygon	A	180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A		BIVPTDF
801	Acidseal	A	All %; 150° max.	BIPTSDF
802	Acidseal	A	All %; 150° max.	BIPTSDF
805	Butyl	A	Dry salt; aqueous sol.; Rm.	
809	Fairprene	A		
817	Heresite	A	Sat.; 212° max.	
835	Perbunan	A	Dry salt; aqueous sol.; Rm.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	A		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTSDF
848	Silastic	A	ASTM D-543-43	
849	Superflex	A	All %; 150° max.	BIPTSDF
853	Thiokol	A	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	A	All %; 150° max.	BIPTSDF
856	Vistanex	A	Dry salt; aqueous sol.; Rm.	
913	Redwood	A	25%; 30°–76°; 22 yr.; Tanks always full; chem. plant	T
		F	20%; 40°–220°; 5 yr.; Soap plant	T
		A	2½%; 130°–200°; Packing plant	T
		A	36,000 ppm.; 40°–100°; 4 yr.; Petroleum plant	T
		A	1–2%; 75°; 18 yr.; Olive cannery	T
		A	8½% + 0.5% Acetic acid; 30°–110°; paraffin-L; olives	T
		A	Seawater; 36°–76°; 28 yr.; Tannery	T
		A	Seawater; 70°; 8 yr.; Fish cannery	T

SODIUM HYDROXIDE

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	F		CH
6	Adnic	A		
10–17	Aluminum	X		
19	Alloyco	F	35%; boil.	BV
		F	Molten; 600°	BV
22	Ambraloy	F		CH
23	Ambraloy	F		CH
24	Ambraloy	F		CH
29–40	Ampco	F	0.5% sol. max.	
54	Brass	V		CH
61	Brass	V		VCH
63	Brass	VF		PCH
66	Bronze	V		
73	Bronze	F		VT
74	Bronze	F		V
75	Bronze	F		VP
76	Bronze	F		
77	Bronze	V		PCH
81	CA-FA20	A	Under 20%; boil.	BIVP
		F	Molten; 600°	BIVP
82	CA-MM	A	Under 20%; boil.	BIVP
		A	Molten; 600°	BIVP
85	Cast Iron	A		
86	Cast Iron	A		
87	Causal	A	40% max.; 230°	B
88	Chlorimet	A	All % and temp.	BIVCHF
89	Chlorimet	A	All % and temp.	BIVHF
111	Copper	V		
114	Copper	F		PTCHR
117	Copper	V		P
118	Copper	V		
123	Cupro-Ni	A		CH
124	Cupro-Ni	A		
127–133	Dowmetal	V	3%	
139	Durco	A	All % and temp.	BIVHF
140	Durichlor	A	All % and temp. (except boil.)	BIVPCHFR
141, 142	Durimet	A	All % and temp.	BIVCH
143	Duriron	A	All % and temp. (except boil.)	BIVPHFR
148	Everdur	F		BIVR
149	Everdur	F		PTCHDR
150	Everdur	F		PCH
156	Gold	A	All %	
159	Hastelloy	A	All % to boil.	BIV
160	Hastelloy	A	All % to boil.	BIV
161	Hastelloy	A	All % to boil.	BIV
162	Hastelloy	A	All % to boil.	
163	Stellite	A	All % to boil.	BIV
165	Stellite	A	All % to boil.	BIV
184	Inconel	A	50%; 180°	
		A	75%; 275°	
185	Inc-Clad	A		BTSCH
216	Monel	A	50%; 180°	BIVPTCHDF
		A	75%; 275°	
217	Monel-Clad	A		BTSCH
219	Muntz	V		CH
224	Nickel	A	50%; 180°	BIVPTSCHDF
		A	75%; 275°	
225	Ni-Clad	A	70% max.	BTSCH
226	Nick-Sil.	A		Instruments
231	Ni-Resist	A	50%; 180°	BIVPH
		A	75%; 275°	
233	NS-5	A	All % and temp.	
234	Olympic	V		
235	Olympic	V		
236	Palladium	A	All %	
240	Platinum	A	Any temp.	
242	Ir-Plat.	A	Any temp.	
244	Rh-Plat.	A	Any temp.	
245	Pyrasteel	V		
249	Resistac	A		BIVCHF
268	Silver	A	Any temp.	
270	304-Clad	A	20% max.; 70°	BTSCH
271	316-Clad	A	20% max.; 70°	BTSCH
274	430-Clad	A	20% max.; 70°	BTSCH
275	St. 301	A	Solutions	BIVTSCH
276	St. 302	A	Solutions	BIVTSCH
		A	20%; 230°	
		A	Melting; 610°	
		A	20% max.; 70°	VTSCDF
		A	Weak or medium	
		X	Strong	

No.	Material	Rating	Exposure Conditions	Applications
278	St. 303	A	Solutions	IV
279	St. 304	A	Solutions	BIVPTSCH
		A	20% max.; 70°	VTSCDF
		A	Under 20%; boil.	BIPT
		X	Molten; 600°	
280	St. 308	A	Solutions	BIVPTSCH
281	St. 309	A	Solutions	BIVTSCH
282	St. 310	A	Solutions	BIVPTSCH
283	St. 316	A	Solutions	BIVPTSCH
		A	Melting; 610°	
		A	20% max.; 70°	VTCHDF
		A	Under 20%; boil.	BIPT
		X	Molten; 600°	
284	St. 317	A	Solutions	BIVPTSCH
285	St. 321	A	Solutions	BIVPTSCH
286	St. 347	A	Solutions	BIVPTSCH
287	St. 403	A		IV
288	St. 405	A		BIVTSCH
290	St. 410	A		BIVPTSCH
		X	Cold; strong	
		X	All %; boil.	
		A	Cold; weak or medium	
		A	Under 20%; boil.	BIVP
		X	Molten; 600°	
291	St. 414	A		IV
292	St. 416	A		IV
		A	Cold; weak or medium	
		X	Cold; strong	
		X	All %; boil.	
293	St. 418	A		
294	St. 420	A		
		A	Weak and medium	
		X	Strong	
295	St. 430	A		BIVPTSCH
		A	20% max.; 70°	VTSCHDF
		A	Weak or medium	
		X	Strong	
296	430-F	A		IV
297	St. 431	A		IV
298	St. 440-A	A		
300	St. 440-C	A		IV
301	St. 442	A		BIVTSCH
303	St. 446	A		BIVPTSCH
313	St. CF-7	A	50%; boil.	
316	St. CF-20	A		BIV
319	St. CF-7M	A	70%; boil.	
364	Stoody	A	25%; boil.	
365	Stoody	F	25%; boil.	
367	Super-Ni	A		PTCH
368	Tantalum	X		
369	Telnic	V		
387	Stainless	A	Weak and medium	
		X	Strong	
388	Stainless	A	Weak or medium; strong, cold	
		X	Strong, boil.	
389	Stainless	A	Weak; medium, cold	
		X	Strong; medium, boil.	
390	Worthite	A	50%; 260°	BIV
		A	70%; 200°	BIV
392	Wyndaloy	A	Very dilute; 68°	
		AV	Moderate dilution; 68°	
		AV	Conc.; 68°	
401	Karbate	A	All %; to boil.	BIVPH
402	Karbate	A	All %; to boil.	BIVPH
403	Kemprul	A	All %; any temp.	TR
404	Acheson	A	All %; any temp.	TR
500	Sul. cement	X		
501	Sul. cement	X		
502	Furan cem.	X		
503	Furan cem.	A	360° max.	PT
504	Phen. cem.	X		
505	Phen. cem.	X		
506	Silicate cem.	X		
507	Silicate cem.	X		
508	Acichlor	F	Dilute and conc.; 300°	
510	Acitite	X	Dilute and conc.; 250°	
513	Asplit	X		
514	Asplit	X		
515	Basalit	X		
518	C-Basalit	X		
521	Causplit	A	All %; 350° max.	
523	Duralon	A	330° max.	BIPTCHDF
524	Durisite	A	350° max.	BIPTCHDF
534	N-Series	A	70% max. at 160°	BIVPTCDFR

No.	Material	Rating	Exposure Conditions	Applications
535	Nukem	A	50%	T
536	Nukem	X		
538	Penchlor	X		
539	Penchlor	X		
540	Penchlor	X		
541	Pennsalt	A	All %; 350° max.	
542	Permanite	A	360° max.	TD
544	Plastite	A	175° max.	PTSD
545	P-Basalit	X		
554	Silastic	F	10%; ASTM D-543-43	
		A	50%; ASTM D-543-43	
556	Staminite	X		
559	Thiokol	F	150° max.	
600	Acid Brick	A	Dil.	TDR
		V	Conc.	
603, 612, 615	Glass	V	Better at low % and temp.	
604	Coratherm	X	Conc.; hot	
606	Stoneware	V	Under 10% at 77°	BIVPTDFR
607	Glass-L.	V		PTCH
610	Stoneware	X		
611	Porcelain	V	Dil.; cold	BIPTDR
614	Glass-L.	V	Not recommended	BTCH
616	Pyrex	X	Conc.	
617	Stoneware	X	Conc.; hot	
618	Vitreo	X		
621	Vycor	X	Conc.	
700	Ace Saran	A	50%; 77°	P
703	Compar	X		
704	DC Silicone	A		
706	Formica	F	10%; Rm.	F
		F	5%; 170°	F
707	Formica	F	20%; boil.	T
		F	50%; Rm.	T
708	Formica	A	10% max.; 122°	P
713	Haveg	A	All conditions	
715	Heresite	V	5%; 70°	
718	Koroseal	A	35%; 90°	TD
		A	10%; 130°	TD
720	Lamicoid	X		
723	Nixon	X		
724	Nixon	X		
726	Nukemite	A	50%; Rm.	PTSDF
727	Nylon	A		
728	Nylon	A		
729-732	Nylon	A		
733	Permanite	A	360° max.	BVPTD
735	Polythene	A	50%	
736	Pyroflex	A		PTCHD
737	Resilon	A	175° max.	PTSD
738	Resistoflex	X		
739	Resistoflex	X		
740	Saran	F	77°	
741	Sealon	A	160° max.	BPTDF
742	Teflon	A	Rm.	VP
744, 745	Textolite	V		BI
746	Tygon	A	180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A		BIVPTDF
801	Acidseal	A	All %; 150° max.	BIPTSDF
802	Acidseal	A	All %; 150° max.	BIPTSDF
805	Butyl	A	Rm.	
809	Fairprene	A		
814	GE Silicone	V		VPTDF
817	Heresite	A	70%; 158° max.	
836	Natural (S)	A		
837	Natural (H)	A		
838	GR-S (S)	A		
839	GR-S (H)	A		
840	GR-A (S)	A		
841	GR-A (H)	A		
842	GR-M (S)	A		
843	GR-P (S)	X		
844	GR-I	A		
846	Saniprene	A	All %; 150° max.	BIPTSDF
848	Silastic	A	10%; ASTM D-543-43	
		A	50%; ASTM D-543-43	
849	Superflex	A	All %; 150° max.	BIPTSDF
853	Thiokol	F	150° max.	T
854	Thiokol	A	150° max.	PTSCDF
855	Triflex	A	All %; 150° max.	BIPTSDF
856	Vistanex	A	Rm.	
913	Redwood	A	3½%; 75°; 15 yr.; Olive cannery	
		A	1-2% + dil. H_2SO_4; 40°-212° Soap plant	

SULPHURIC ACID

No.	Material	Rating	Exposure Conditions	Applications
3	Admiralty	V		
4	Admiralty	V		CH
6	Adnic	V	0.5-2.5%, 50%, 95%	
10-17	Aluminum	A	Fuming; Rm.	S
		FX	Dil.; Rm.	
19	Alloyco	A	All %; 70°	BV
		A	50% max.; boiling	BV
		A	50%-93%; 150°	BV
		A	93% sulphuric to 65% oleum; 150°	BV
22	Ambraloy	V		CH
23	Ambraloy	V		CH
24	Ambraloy	V		CH
29-40	Ampco	A	To 10%; 212° max.	BIVPTCHDF
		V	10-75%; depends upon conditions	BIVPTCHDF
42	Antaciron	A	All conditions, with slurry, reducing or oxidizing	BIV
51	Berylco	A	Cold	
54	Brass	X		
61	Brass	X		
63	Brass	V		PCH
65	Bronze	V		
67	Bronze	A	Dil.; hot and cold	BIV
73	Bronze	V		VT
74	Bronze	V		V
75	Bronze	V		VP
76	Bronze	V		
77	Bronze	X		
81	CA-FA20	A	5% aerated and agitated; 70°	
		A	5% aerated and agitated; 176°	
		A	78% aerated and agitated; 176°	
		A	93% aerated and agitated; 70°	
82	CA-MM	A	5% aerated and agitated; 70°	
		F	5% aerated and agitated; 176°	
		X	73% aerated and agitated; 176°	
		F	93% aerated and agitated; 70°	
85	Cast Iron	A	Over 77%	
86	Cast Iron	A	75-95%, 98%-fuming	
		X	To 75%	
87	Causul	A	Cold or hot to 60° Be.; Cold above 60° Be.	B
88	Chlorimet	A	All % and temp. except hot over 80%	BIVCHF
89	Chlorimet	A	Dil. all temp.; strong moderate temp.	BIVHF
		F	Intermediate %	BIVHF
111	Copper	V		
114	Copper	V		PTCHR
118	Copper	V	95%	
119	Corrosiron	A	25, 87, 95%; Rm.; unagitated; C.P.	BIVPTCHDFR
123	Cupro-Ni	V		CH
124	Cupro-Ni	V	95%	
139	Durco	A	All % to 176°	BIVHF
		A	Under 45% to boil.	BIVHF
140	Durichlor	A	All % and temp.	BIVPCHFR
141	Durimet	A	All % to 176°	BIVCHF
		A	Under 25% boil.	BIVHF
		F	78% hot	BIVHF
142	Durimet	A	Under 10% boil; all % to 176° except near 60° Be. (141 preferred)	BIVHF
143	Duriron	A	All % and temp.	BIVPHFR
148	Everdur	V		BIVR
149	Everdur	V		PTCHDR
150	Everdur	V		PCH
156	Gold	A	To boil.	
159	Hastelloy	A	Under 50%; to boil.	BIVPTCHDF
		A	Over 50%; to 160°	BIVPTCHDF
160	Hastelloy	A	Under 60%; to boil.	BIVPTCHDF
		A	Over 60%; to 160°	BIVPTCHDF
161	Hastelloy	A	Under 50%; to boil.	BIVPTCHDF
		A	Over 50%; to boil.	BIVPTCHDF
162	Hastelloy	A	All % (except 55%) to boil.	BIVP
163	Stellite	A	All %; Rm. only	BIV
165	Stellite	A	All %; Rm. only	BIV
184	Inconel	A	5%; 86°; unaerated	
		X	5%; 86°; aerated	
		X	19%; boil.	
185	Inc-Clad	A	Conc.; 70°	BTSCH
191	Lead	A		PTH
193, 196, 200, 266	Lead	A	Under 96% to 60°; under 85% to 428° (No. 193, 248° max.)	BIPTSCHDF
216	Monel	A	5%; 86°; unaerated	BIVPTCHDF
		F	5%; 86°; aerated	
		A	19%; boil.	
		A	45, 60%; 140°; unaerated	
		A	80%; 86°	
217	Monel-Clad	A	Conc.; 70°	BTSCH
219	Muntz	X		
224	Nickel	A	5%; 86°; unaerated	VPTH
		X	5%; 86°; aerated	
		X	19%; boil.	
225	Ni-Clad	A	Conc.; 70°	BTSCH
226	Nick-Sil.	V		
231	Ni-Resist	A	5%; 86°; unaerated	BIVP
		X	5%; 86°; aerated	
		X	19%; boil.	
233	NS-5	A	Under 60° Be.; hot or cold	V
234	Olympic	V	95%	
235	Olympic	V	95%	
240	Platinum	A	To boil.	
242	Ir-Plat.	A	To boil.	
244	Rh-Plat.	A	To boil.	
245	Pyrasteel	V		
249	Resistac	A	66° Be. max.	BIVCHF
270	304-Clad	A	Conc.; 70°	BTSCH
271	316-Clad	A	5%; 10%; fuming; 70°	BTSCH
274	430-Clad	A	Conc.; 70°	BTSCH
275	St. 301	V	Conc.; Rm.	
276	St. 302	V	Conc.; Rm.; 60° Be. min.; 180° F max.	
		A	Diluted 1:20; 70°	
		X	Diluted 1:20; boil.	
		A	Diluted 1:10; 70°	
		X	Diluted 1:10; boil.	
		A	Diluted 1:1; 70°	
		X	Diluted 1:1; boil.	
		A	Conc.; 1:0; 70°	
		F	Conc.; 1:0; 212°	
		X	Conc.; 1:0; 300°	
		A	Fuming, 11% free, SO_3; 212°	
		A	Fuming, 60% free, SO_3; 70°,100°	
278	St. 303	V	Conc.; Rm.; 60° Be. min.; 180° F max.	
279	St. 304	V	Conc.; Rm.; 60° Be. min.; 180° F max.	
		A	5%; aerated and agitated; 70°	BIVP
		X	5%; aerated and agitated; 176°	
		X	78%; aerated and agitated; 176°	
		A	93%; aerated and agitated; 70°	BIVT
280	St. 308	V	Conc.; Rm.; 60° Be. min.; 180° F max.	
281	St. 309	V	Conc.; Rm.; 60° Be. min.; 180° F max.	
282	St. 310	V	Conc.; Rm.; 60° Be. min.; 180° F max.	
283	St. 316	V	Conc. or 18° Be.; Rm.	
		V	5% at 120° F max.; 60° Be. min., 200° max	
		A	Diluted 1:20; 70°	
		F	Diluted 1:20; boil.	
		A	Diluted 1:10; 70°	
		X	Diluted 1:10; boil.	
		A	Diluted 1:1; 70°	
		X	Diluted 1:1; boil.	
		A	Conc., 1:0; 70°	
		F	Conc., 1:0; 212°	
		X	Conc., 1:0; 300°	
		A	Fuming 11% free SO_3; 212°	
		A	Fuming 60% free SO_3; 70°, 160°	
		A	5%; aerated and agitated; 176°,	BIVP
284	St. 317	V	Over 15° Be.; Rm.	
285	St. 321	V	Conc.; Rm.	
		V	Over 60° Be.; 180° F max.	
286	St. 347	V	Conc.; Rm.	
		V	Over 60° Be.; 180° F max	
287	St. 403	V	Conc.; Rm.	
288	St. 405	V	Conc.; Rm.	
290	St. 410	V	Conc.; Rm.	
		X	5%; aerated and agitated; 176°	
		X	78%; aerated and agitated; 176°	
		A	93%; aerated and agitated; 70°	BIVP
291	St. 414	V	Conc.; Rm.	

No.	Material	Rating	Exposure Conditions	Applications
292	St. 416	V	Conc.; Rm.	
293	St. 418	V	Conc.; Rm.	
294	St. 420	V	Conc.; Rm.	
295	St. 430	V	Conc.; Rm.	
		F	Diluted 1 20, 70°	
		X	Diluted 1 20, boil.	
		F	Diluted 1:10, 70°	
		X	Diluted 1 10, boil.	
		A	Conc. 1:0, 70°	
		F	Conc. 1:0, 212°	
		X	Conc. 1:0, 300°	
296	St. 430-F	V	Conc.: Rm.	
297	St. 431	V	Conc.; Rm.	
298	St. 440-A	V	Conc.; Rm.	
300	St. 440-C	V	Conc., Rm.	
301	St. 442	V	Conc., Rm.	
303	St. 446	V	Conc.; Rm.	
316	St. CF-20	A		BIV
364	Stoody	A	10%; Rm.; boil.	
365	Stoody	A	10%; Rm.	
		X	10%; boil.	
367	Super-Ni	V		PTCH
368	Tantalum	V	98% max.; 347° max. at 98%; avoid free SO_3	H
369	Telnic	V	95% and under	
387	Stainless	X	All %	
388	Stainless	X	All %	
389	Stainless	A	Weak; strong	
		X	Medium	
390	Worthite	A	All %; 125°	BIV
		A	1-50%, aerated; 175°	BIV
		A	96-100%, aerated; 175°	BIV
		A	100-110%; 200°	BIV
		F	50-93%, aerated; 140°	BIV
392	Wyndaloy	A	Very dilute	
		V	Other %	
401	Karbate	V	96% max.; 338° max.	BIVPTCHD
402	Karbate	V	96% max.; 338° max.	BIVPTCHD
403	Kempruf	A	100% max. to boil.	PTDR
		A	115% max. to 158°	PTDR
404	Acheson	A	50% max.; to boil.	PTDR
500	Sul. cement	A	50% max.; 200° max.	PTD
501	Sul. cement	A	50% max.; 200° max.	PTD
502	Furan cem.	A	50% max.; 360° max.	PTD
503	Furan cem.	A	50% max.; 360° max.	PTD
504	Phen. cem.	A	50% max.; 360° max.	PTD
505	Phen. cem.	A	50% max.; 360° max.	PTD
506	Silicate cem.	A	Strong sol. only; 1,600° max.	PTD
507	Silicate cem	A	Strong sol. only; 1,600° max.	PTD
508	Acichlor	V	Dilute and conc.; 300°	
510	Acitite	A	Dilute and conc.; 250°	
513	Asplit	A	All %; 350° max.	
514	Asplit-F	A	All %; 350° max.	
515	Basolit	A	Diluted; 200° max.	T
517	Carboline	A	50% max.	
518	C-Basolit	A	Diluted; 200° max.	T
521	Causplit	A	All %; 350° max.	
523	Duralon	F	Sp. gr. 1.5; 350° max.	BIPTCHDF
524	Durisite	F	Sp. gr. 1.5; 350° max.	BIPTCHDF
532	Lumnite	A	1% max.; 90° max.	TD
535	Nukem	A		T
536	Nukem	A		T
537	Pecomastic	A	Dilute and conc.; 300°	
538	Penchlor	A	All %; 750° max.	
539	Penchlor	A	All %; 750° max.	
540	Penchlor	A	All %; 500°-2,000°	
541	Pennsalt	A	All %; 350° max.	
542	Permanite	V	Dil.; cold	TD
		X	Conc.; hot	
544	Plastite	F	175° max.	PTSD
545	P-Basolit	A	Dil.; 200° max.	T
554	Silastic	A	10%-30%; ASTM D-543-43	
		X	Conc.; ASTM D-543-43	
556	Staminite	A	All %	T
559	Thiokol	X		
600	Acid Brick	A		TDR
603, 612, 615	Glass	A		THDR
604	Ceratherm	A	200°-400°, depending on design	BIPTSCHDFR
606	Stoneware	A	All conditions	BIVPTCHDFR
607	Glass-L	A	600° max.	PTCH
610	Stoneware	A	All %; any temp.	BIVPTCHDR
611	Porcelain	A	All % and temp.	BIPTDR
614	Glass-L	A	All %; 338° max.; agitation	BTCH
616	Pyrex	A		
617	Stoneware	A	140°-160°	BIPTSCHDFR
618	Vitreo	A	1,000° max.	
619	Vitreosil	A		PCH
621	Vycor	A		
700	Ace Saran	A	60%; 122°	P
704	DC Silicone	V		
706	Formica	F	25% max.; Rm.	
707	Formica	F	25% max.; Rm.	T
708	Formica	X	All %	
711	Haveg	V	75%; cold	BIVPTFDR
		V	50%; 300° max.	BIVPTFDR
718	Koroseal	A	50%; 150°	TD
		A	60%; 100°	TD
720	Lamicoid	X		
723	Nixon	A	3%	S
		F	30%	S
724	Nixon	A	3-30%	S
726	Nukemite	A	40%; Rm.	PTSDF
727	Nylon	X	Conc.	
728	Nylon	X	Conc.	
729-732	Nylon	X		
733	Permanite	V	Dil.; cold	PV3DT
		X	Conc.; hot	
735	Polythene	X	Conc.; hot	
		V	Rm.	
736	Pyroflex	V		PTDCH
737	Resilon	F	175° max.	PTSD
740	Saran	F	77°	
741	Sealon	A	160° max.	BTPDF
742	Teflon	A	Rm.	VP
744, 745	Textolite	V		BI
746	Tygon	V	Dil. to med. conc.; 180° max.	BIPTSCHDF
800	Ace Hd. Rub.	A	50%	BIVPTDF
801	Acidseal	A	50%; 150° max.	BIPTSDF
		A	60%; 100° max.	BIPTSDF
802	Acidseal	A	50%; 150° max.	BIPTSDF
		A	60%; 100° max.	BIPTSDF
805	Butyl	V	70%; 140° max.	
809	Fairprene	V		
814	GE Silicone	V		VPTDF
817	Heresite	A	50%; 122° max.	
836	Natural (S)	V		
837	Natural (H)	V		
838	GR-S (S)	V		
839	GR-S (H)	V		
840	GR-A (S)	V		
841	GR-A (H)	V		
842	GR-M (S)	V		
843	GR-P (S)	X		
844	GR-I	V		
846	Saniprene	A	50%; 150° max.	BIPTSDF
		A	60%; 100° max.	BIPTSDF
848	Silastic	A	10%-30%; ASTM D-543-43	
		X	Conc.; ASTM D-543-43	
849	Superflex	A	50%; 150° max.	BIPTSDF
		A	60%; 100° max.	BIPTSDF
853	Thiokol	X	150° max.	
854	Thiokol	F	150° max.	PTSCDF
855	Triflex	A	50%; 150° max.	BIPTSDF
		A	60%; 100° max.	BIPTSDF
856	Vistanex	V	70%; 140° max.	
913	Redwood	A	5-12%; 36°-190°; Falsewood-L; steel pickle	T
		A	5-8% + Dil. HNO_3; 36°-90°; asphalt-L; explosives mfgr.	T
		A	pH4.1; 36°-80°; 17 yr.; Plating works	T
		A	pH5.8; 36°-90°; 20 yr.; Plating works	T
		A	4-5%; 36°-140°; 37 yr.; Armor plate pickling	T
		A	3%; 36°-90°; 7 yr.; Plating works	T
		A	2% + 1.5% HCl; 40°-180°; 21 yr.; Chemical plant	T
		A	1.5%; 36°-120°; 27 yr.; Tannery	T
		A	1% + 1-5% $CuSO_4$; 36°-170°; 13 yr.; Chemical plant	T
		A	0.5% + dil. NaOH; 40°-115°; 2 yr.; Soap specialties	T
		A	Dil. + dil. HCl + dil. lead acetate; 40°-150°; 13 yr.; paint	T
		A	Dil.; 60°-200°; 2 yr.; Petroleum refinery	T

RICHARD E. CHADDOCK *Hercules Powder Co., Wilmington, Del.*

Practical Aspects in Design of LIQUID AGITATORS

Despite all that has been written on the design of agitators for liquids, and mixtures of liquids with solids or gases, the subject is still far from exact and there is still room for practical information that will in most cases insure a correct design without resort to theories and formulas of doubtful validity. The author presents such a system, which has had the benefit of much actual and successful use.—*Editors*

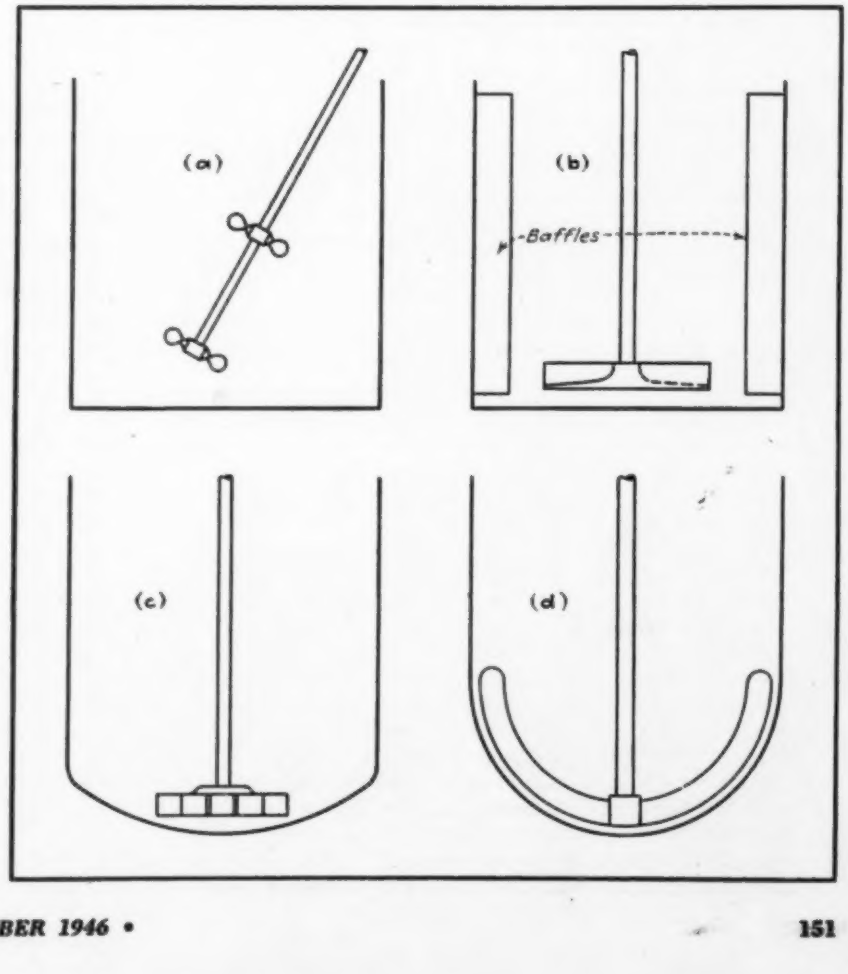
Agitation or mixing is perhaps one of the most important, but least understood, unit operations in chemical engineering. There is scarcely a vessel in a chemical plant which does not require some form of agitation, be it simply for suspending solids in a slurry or—the more difficult case—the dispersion of gas in a liquid. In certain chemical reactions the rate depends immeasurably upon the degree of agitation. The dissolving of solids, and the heating and/or cooling of liquids in tanks is influenced by agitation. Chemical engineers are discovering every day, to an always increasing extent, the importance of agitation as a critical variable in chemical processes.

The subject of agitation has been investigated quite thoroughly in the laboratory and reported by A. W. Hixson[1] in a recent article which gave 127 references to various publications in this field. These publications represent considerable work and the expenditure of a large amount of time and effort. However, an air of mystery still surrounds this unit operation and, so far, a straight-forward method for the selection and design of liquid agitators has not been published. In the majority of cases the design chemical engineer seeks the advice of the agitator equipment companies but, despite this, a need is felt for a simple procedure whereby efficient liquid agitators can be designed with assurance, or proposed designs can be checked.

The author is familiar with an agitator design, and the subsequent equipment installation by a large mixing company, where a 15-hp. motor was used to drive the agitator impeller. As the agitation appeared ineffective, a power test was made using a recording wattmeter and it was found that the agitator impeller was actually consuming only a little over 1 hp. In all honesty, perhaps the complete facts were not given to the designer, but an error of this magnitude should have been discoverable with available design methods.

Until sufficient performance data on pilot plant mixers have been accumulated and correlated, it will probably always be necessary to resort to small-scale experiments to obtain design data for specifying certain agitators to meet the unusual conditions occasionally encountered in complex chemical reactions. However, certain data are now available for the design of liquid agitators, and the design does not involve the application of numerous theories and formulas. With the help of these data, large-scale agitators can be designed from pilot plant experiments with some degree of confidence.

Fig. 1—Agitators of these four types suffice for 95 percent of liquid mixing problems; modifications handle most others



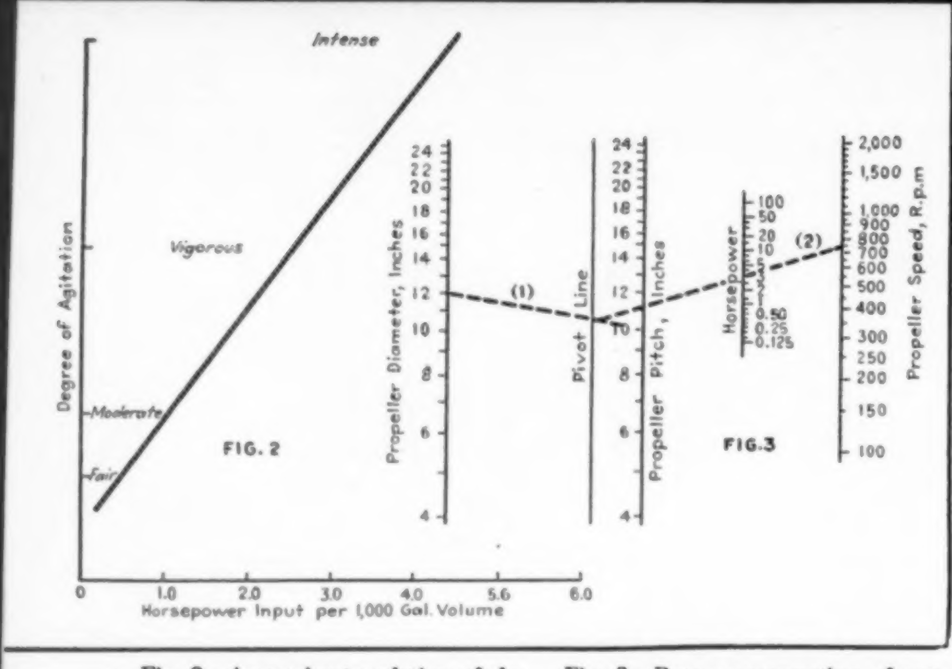


Fig. 2—Approximate relation of degree of agitation and power input per 1,000 gal. of solution

Fig. 3—Power consumption of propeller type agitators (from Badger *et al*, *Chem. & Met.*, 27, 1176, 1922)

AGITATOR IMPELLER TYPES

Selection of the proper agitator impeller is the first consideration in the design of a liquid agitation unit. There are four main types of agitator impellers, including:

a. Propellers
b. Flat-bladed paddles
c. Turbines
d. Anchors.

The general types of impellers, well-known to all engineers, are illustrated in Fig. 1a to d. Besides these types, there are many tricky designs which are variations of those mentioned, some of which have advantages for certain special uses. In 95 percent of the mixing problems encountered, one of the standard types properly designed will perform the required mixing adequately. Each of these standard impellers has its proper place when agitators are used for liquid-liquid mixing, liquid-solid mixing, liquid-gas contacting, and liquid-gas-solid contacting.

Propellers are principally used as high-speed mixers for some cases of liquid-solid mixing and liquid-liquid mixing and, as such, have a definite place in the liquid agitator field. In mixing operations requiring mechanical cutting and shearing, propellers have proved most satisfactory. Their power consumption is low, together with a low initial capital investment. They are useful mainly in small-capacity vessels; however, in the case of large-diameter and large-capacity storage or blending tanks, propeller agitators have been used successfully by installing two or more units around the circumference of the tank near ground level. A propeller agitator is not basically effective in a highly viscous or dense solution, and care must be taken to install the propeller in the tank off-center either horizontally or vertically to prevent vortexing and swirling of the entire contents of the vessel. A very good article on the use of the marine-type propeller and the so-called "radial" propeller was recently published[8].

The flat-bladed paddle agitator having two, three, or four blades has been used extensively in the chemical industry. Agitators of this type have usually been recommended for use at low speeds only, but with proper design they can be used at speeds up to 180 r.p.m. Paddle agitators are of low initial cost, easily fabricated or modified in the field, and are useful in nearly all types of mixing. In considering a mixing problem, careful thought should be given to the use of a paddle-type impeller as it is highly effective over a wide range of solution viscosities and densities.

Turbine-type agitators, with both open and shrouded impellers, are likewise popular in the industry and can be used for nearly all types of mixing. Turbine impelpers are expensive and care must be taken in fabrication to obtain good balance; however, a properly designed turbine impeller is well-suited for the difficult job of dispersing gases in a liquid. A few years ago[9] a modification of the conventional turbine impeller known as the "disperser-type" turbine was introduced for liquid-gas contacting and has proved to be very effective.

Anchor-type impellers are mainly used in glass-lined vessels where their shape leads to ease of enameling operations. They are most helpful where viscous materials or liquids containing a high percentage of solids are agitated. This type of agitator, slightly modified, is used in Dopp kettles to prevent a build-up of solids on the sides of the kettle because such a build-up lowers over-all heat transfer rates. Anchor-type agitators are used for conditions requiring a low degree of agitation, and operate at speeds under 120 r.p.m.

One of the most difficult problems in designing an agitator is what criterion to use in describing the desired degree of agitation and how to translate this criterion into design terms.

Agitation is usually spoken of in terms of "vigorous" or "mild" or some other such nonspecific term. A single quantitative term which can be applied to mixing and agitation has not, as yet, been found. The design engineer is faced with the problem of furnishing "good agitation" because the operating or research group usually specifies "good agitation" as very necessary for carrying out the proposed chemical reaction; or sometimes, he has to design an agitator which will "just keep the solids in uniform suspension."

The criterion of power input per unit volume is recommended for the present state of the art as one means of specifying the degree of agitation. It is realized that this procedure is only qualitative, but the results obtained have been proved to be reliable and adequate in most cases. Fig. 2 shows the relationship of degree of agitation and horsepower input per unit volume with solutions similar to water. When this chart is used for solutions having high viscosities and densities, the indicated power input should be increased 25 to 50 percent to obtain the same degree of agitation. This plot, based on the experience of the author and others, is intended only as a guide since, as mentioned previously, the terms "mild agitation" and "vigorous agitation" have little value and must be viewed in the light of experience.

POWER CONSUMPTION

Once the proper agitator impeller has been selected and the power input to give the required degree of agitation determined, it is necessary to calculate the size and speed of the impeller to obtain the correct power input.

A nomograph shown in Fig. 3 has been developed for calculating the power requirements for propeller-type impellers of certain pitch and diameter at various speeds. This nomograph is based on agitation in solutions of the viscosity of water. The power consumption is the power actually consumed by the propeller and not the size of the motor for the agitator unit. However, since the nomograph is based on the assumption that the propeller is 100 percent efficient (whereas efficiency is actually about 60 percent), the power figure obtained will be conservative. With this factor of safety already incorporated in the power figure no additional increase is necessary when agitating fluids having a viscosity up to 100 centipoises.

For flat-bladed paddles power requirements may be estimated by the use of the following equation developed by White *et al*[4].

$$P = 0.00013 L^{2.72} Z^{0.14} N^{2.86} \rho^{0.86} D^{1.1} W^{0.3} H^{0.3}$$

where: P = horsepower; L = paddle

length (ft.); Z = Absolute viscosity (lb. per sec.-ft.); N = Revolutions per second; ρ = Density (lb. per cu. ft.); D = Tank diameter (ft.); W = Paddle width (ft.); and H = Liquid depth (ft.).

Experimental work on which this equation is based covered a wide range of paddle sizes, speeds, etc., and the final correlation included some data on four-bladed as well as two-bladed paddles. This formula is fairly reliable, but should be carefully interpreted by the designer and when applied for three- and four-bladed paddles the power computed should be increased by approximately 25 and 50 percent, respectively.

In Fig. 4 the power consumption as a function of speed is given for a number of standard-size turbine-type impellers. This power is the net power delivered to the turbine when agitating a solution of the viscosity of water. The effect of viscosity on the power requirements of turbine impellers is shown in Fig. 5. The power values obtained from these figures are reliable and can be used safely.

Very few data are available on the power consumption of anchor-type agitators, probably because of their limited use. However, as a rough estimate the power can be computed using the formula for flat-bladed paddles by assuming the paddle length to be the horizontal width of the agitator, and increasing this power value by the ratio of the total surface of the agitator to the surface used in the calculation.

DESIGN DETAILS

In the actual design of an agitator unit, careful consideration should be given to the design of the mixing vessel. For effective agitation, that is, the proper degree of agitation required by any one job, the vessel should have a ratio of height to diameter of from 1.0 to 1.5. Whenever good and effective agitation is desired, the mixing vessel should be baffled in order to increase the turbulence which, incidentally, will increase the power consumption from 10 to 25 percent and should be allowed for in selecting the drive motor. These baffles can consist of three or four equally spaced vertical members fastened to the side of the vessel. They should extend from above the liquid level down to a point below the location of the agitator impeller and should have a width about one-tenth the vessel diameter.

The selection of the diameter of a liquid impeller agitator is always something of a problem, but its solution for turbine impellers is made relatively easy by the fact that in most cases the range of standard sizes available limits the choice. As a starter, an impeller diameter one- to two-thirds the tank diameter may be chosen; then this size should be matched with the standard impellers available.

There are some data which indicate that the length of a paddle-type impeller blade should be approximately equal to the radius of the mixing vessel. Another limiting factor when closed vessels are agitated is to select an impeller that will go through the manhole. The width of a liquid impeller agitator must be balanced against the diameter and speed to obtain the proper power input. A turbine impeller usually has a width about one-tenth of the diameter, while the width of a paddle-type impeller should be from one-eighth to one-quarter the length. The blades of a standard turbine impeller are usually inclined at an angle of 45 deg. Experience of the author indicates that the blades of the paddle-type impeller should be inclined at 30 to 45 deg. from the vertical.

The exact location of the impeller agitator in the mixing vessel has been a subject of controversy for many years. Some designers place the impeller one-third of the distance up from the bottom of the tank to the liquid level. Others place the impeller at a distance from the bottom of the tank equal to the impeller width, whereas still others place the impeller approximately one-half of the diameter of the impeller from the bottom of the tank. The author's experience indicates that for commercial installations the impeller should be placed approximately 4 to 8 in. above the bottom of the tank. However, this rule should not be followed too rigidly as, for example, in the agitation of liquids in extremely deep vessels or where heavy solids might collect on the bottom.

In the majority of cases, the impeller should rotate in such a direction as to push the liquid downward over the bottom of the tank. There may be a few cases where it will be more advantageous to have the impeller push upward, but these should be determined by experimentation. Several years ago an agitator was installed in a jacketed tank used for cooling a reactor charge from approximately 450 deg. F. to 200 deg. F. By mistake, the turbine impeller was installed to push upward and the rate of cooling was found to be quite low. As soon as the error was discovered and the impeller rotation reversed, the cooling rate increased considerably. This was merely a matter of increasing the turbulence and the velocity of the liquid past the tank walls in order to increase the heat transfer coefficient. In the case of dispersing gases in a liquid where the gas is introduced under the outer edge of the impeller, it has likewise been noted that greatly increased results are obtained with the impeller pushing the liquid downward. In some deep vessels, best agitation may be obtained by use of two impellers on a common shaft rotating so that the lower impeller pushes the liquid downward and the upper impeller pushes upward.

Design details which should be given careful consideration include the diameter of the shaft[5], power losses in the stuffing box[6], inefficiencies of the reduction gears, maximum shaft length, and others more or less of a mechanical nature. The answer to these details can best be obtained from the mixing equipment manufacturer.

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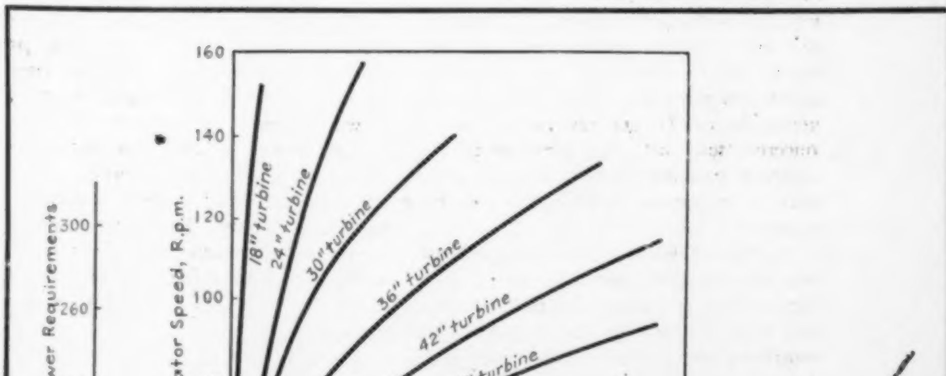
Fig. 4—Power consumption of standard size turbine type liquid-mixing impellers (Courtesy of New England Tank & Tower Co.)

Fig. 5—Effect of viscosity on power consumption of turbine-type impellers ("Chemical Engineers' Handbook," 2nd ed., p. 1554)



1946 CHEMICAL INDUSTRY MEDAL

On November 8 the American Section of the Society of Chemical Industry honored Dr. Willard H. Dow, president of the Dow Chemical Co., by awarding him the Chemical Industry Medal for 1946. Dr. William J. Hale, research consultant for the Dow company and brother-in-law of the medallist, served as personal sponsor while the professional sponsor was Major General Alden H. Waitt, chief of the Army's Chemical Corps. Highlights of the three addresses of the occasion are presented here.—*Editors*

William J. Hale

Alden H. Waitt

The Man

In the fall of 1918, it fell to my lot to repair to Midland and organize organic chemical research of the Dow Chemical Co. In the summer of 1919, Mr. Willard Dow returned to his native city and took up work at the chemical plant. It was as my assistant that he decided to serve for a few months and learn the ways of organic chemicals.

To my way of thinking the most outstanding characteristic of Willard Dow is his inventiveness, coupled with perseverance. Everything that meets his attention stirs up quandaries within him as to how best it may be improved. But along with his inventiveness there is also that urge for preparedness. His general aim seems to concern itself with the appointment of assistants to positions such that will guarantee a maximum performance for the whole.

In this chemical age all further advance must be chemically sound, otherwise it becomes labor lost. It is here that Dr. Dow has bent his best efforts to prepare for enormous production of chemicals from the sea, especially bromine and magnesium; but he has plans for many more from this same source.

Utilization of everything to the best interests of society and to the highest degree has become the incentive of Dow Chemical and its entire personnel. When Dr. Dow once perceives the possibility of a lowering in cost of any chemical of our manufacture his ready mind is alert and pointed to some new adaptation lurking just around the corner. Truly he delights in reconnoitering untrodden paths.

The greatest forward strides of Dow Chemical have followed directly the rise to its presidency of Dr. Willard Henry Dow. His courage and driving force have never faltered.

His Accomplishments

After World War I, Dow and other companies continued to develop production of magnesium, but the others finally abandoned their efforts, convinced it was impossible to produce at a competitive price. Willard Dow pushed research on magnesium recovery, and for more than 15 years chased molecules of magnesium around the brine, sometimes in the red financially, but always in the black technically. The military services reaped the full benefit of these years of research.

Dr. Dow's love of doing the impossible contributed no small part in winning the battle of transportation in World War II. With the spiralling demand for lead tetraethyl in the late 20's and early 30's, many concerns had been attracted by the unlimited supply of bromine in seawater but had abandoned their development efforts as uneconomical. Dow had been producing bromine from the Midland brine since the establishment of the concern. With the experience thus gained, Dow tackled the problem of extracting bromine from the seawater successfully. The ethylene dibromide plant at Kure Beach gave our army the finest motorized equipment of any army.

When our supply of rubber was suddenly shut off after Pearl Harbor, another pioneer development by Dow became vital to our war effort. Styrene furnished the quickest process for the production of synthetic rubber. Dow had been producing styrene commercially since 1937 and was the sole producer at the outbreak of the war. Dow's know-how was made available to the government, and they not only expanded their own production but also assisted competitor-operated plants by furnishing engineering service and in training their operating personnel.

In addition, Dow has pioneered work in production of butadiene, on which they had started development work in the late 30's.

A byproduct of Dow's early research on production of ethyl cellulose and styrene played an important role in the development of certain wartime applications that have been secret until very recently. Their polyfiber radomes were used extensively. From this same polyfiber came a new type of separator for storage batteries.

One of the major developments of the war was the radio proximity fuze. The pioneering work of Dow in molding ethyl cellulose provided the solution which permitted early production of this fuze.

A little publicized side of Dr. Dow's technical achievements is in the field of human engineering. This sympathetic interest had much to do with the fact that during all the war years no Dow plant, and no Dow operated plant, lost a day's production because of strikes or work stoppages.

Another little publicized side of Dr. Dow's technical ability is in the field of

therapeutic agents. He has deep personal interest, and supports extensive research in the development of new treatments for tuberculosis and cancer.

The many sided technical training of Dr. Dow was utilized to the utmost by the government during the war. His counsel was given as a member of a large number of technical advisory committees. The Chemical Advisory Committee of the Army and Navy Munitions Board, The Chemical Warfare Advisory Committee, The Quartermaster Advisory Board, The Rubber Reserve Corporation—these are just a few of his wartime activities.

The American Section of the Society of Chemical Industry is honoring an outstanding American in awarding its Chemical Industry Medal to Dr. Willard Dow. His record before and during the war has been outstanding. It is to such men as he that we must now look in the winning of the peace.

Salts of the Earth

Ours is a scientific company by whose ideals and harmonious cooperation the salts of the earth, the water and the air have been utilized to give man's daily life new meaning. It is the vital constructive force of all industry that has made America great, an example to the people of the world who would attain that same measure of life. This constructive force has issued from a free people—free in their thoughts, in their work and in their ventures. From these salts of the earth has sprung the chemical industry.

When we consider chlorine chemistry, or the chemistry of salt, starting with the electrolytic decomposition of salt into chlorine and caustic soda, we cannot but be astounded at the effect of electricity and electrochemistry upon our lives. These products of the electrochemistry of salt or their diverse compounds are vital to the petroleum, lumber, automobile and textile industries. They go into hundreds of medicinal compounds, fumigants and insecticides to protect our health and our food, as well as being key factors in water purification and sewage treatment. They hold a dominant position in the making of rayon and practically all plastics—in dry cleaning fluids, refrigeration media and fire extinguishers. They are so much a part of us that we can scarcely touch an object that has not in some way been benefited by the chemistry of salt.

Too seldom do we stop to glorify our stupendous industrial successes. Or perhaps we have dwelt too much and too long on success in terms of the dollar—too little in terms of the humanities. We have judged the merit of a company by the extent of its physical assets rather than by the number of human beings with which its operations provide the comforts of life—by the magnitude of its sales rather than the degree to which its products have made life finer and fuller.

Looking back over a number of decades, we can see how each new advance could have been used to wreck and destroy, or to give unwarranted power to one group or another. But the reassuring, the inspiring part of it is that our great advances have come through great men with the vision to see beyond the nearest street corner.

Willard H. Dow

Altogether too many people these days are taking the attitude that they have no responsibility, yet there is not a single man who can honestly say he does not enjoy the benefits of modern society. All benefits, no matter how small, create responsibility, and only by accepting responsibility can we hope to realize the benefits of further progress.

Because the chemical industry, and all industry, has been mindful of its responsibility to civilization, we have in this country an exceedingly high standard of living. Work and more work and hard work has been the means to this end. No Aladdin's Lamp or magic carpet has lifted us to that present plane of living—nor will it carry us to further heights. The blessing of hard work is what we must glorify and live by, and the satisfaction and pleasure of a job well done is a reward no one will ever measure in dollars. Industrial success breeds progress, and the dollar is only the clothing—not the flesh and blood and soul of the offspring.

It is a strange commentary on the intelligence of our people that they so readily forget that we had an economy in our country before we had economists. True principles of economics cannot be discovered by experimentation because of the human factor. And when we try to make an exact science out of the actions of human nature, with the dollar motive the paramount issue, we must necessarily meet with one failure after another. Human nature and its reactions cannot be made into exact science.

The measure of industry's responsibility rests on finding the proper type of man for every job and conversely the proper job for every man. The average man must see his responsibility as well as the industrialist; when these responsibilities are recognized and accepted, then most of our problems are over. In place of such folderol as "the world owes a man a living," we shall hear from every honest citizen, "Every man owes the world something in return for the blessings so freely offered." Each individual in every walk of life must justify that right. There are no rights without responsibility, and conversely, since acceptance of responsibility grants rights.

The ability of the human race to work together to solve a problem by the use of combined intellectual brainpower is the very foundation of our many successes. Therefore it is incumbent on each one of us to apply that brainpower to the solution of our many problems. Nearly everything has a simple solution and any problem should be reduced to its simple fundamentals. For example, if you wish to produce magnesium, you must have an abundant source of raw material. The natural reaction is to consider dolomite or some other magnesium bearing ore, but this is not the truly simple solution. Why mine rock when it is so much easier and cheaper to mine ocean water? And then again, sea water is available to all.

As a large producer of magnesium, it was logically our responsibility to go to the largest source of supply of raw material for its production. As we had commercially demonstrated the practical extraction of bromine in a concentration of 65 parts per million parts of ocean water, so surely the extraction of magnesium, with a concentration of 1,200 parts per million, was feasible. This accomplishment is a matter of record, but its greatest significance may yet lie beyond the horizon. After sodium chloride, magnesium as magnesium chloride is the next most abundant mineral in sea water, and along with it can be accumulated trace elements such as manganese, iron, copper, boron and others. Here then is offered a means of returning these ingredients to the soil for use as soil enrichers and fertilizers.

We see the continents of the world well blessed with the rich resources of the oceans—resources containing recoverable quantities of the order of 4,500,000 tons of magnesium, 85,000,000 tons of sodium chloride and 230,000 tons of bromine per cubic mile, not to mention many thousands more tons of elements of perhaps greater value. The industries of the world are standing ready to offer their every assistance.

Nature offers the opportunity to advance. Our civilization is enlightened chemically, physically and mechanically, but not spiritually. Is it not high time to forsake false issues and return to fundamental thinking—fundamentals that make for a full life, liberty and the pursuit of happiness?

What Readers Think About Equipment Cost Data Plan

Here are a few of the letters that readers have sent to *Chemical Engineering*, commenting on the plan proposed by Henry Eckhardt on page 104 of our September issue. Chemical engineers are badly in need of standard cost estimating data for both chemical equipment and chemical process operation. Past efforts at securing such data have been largely unproductive. Mr. Eckhardt suggests a new type of approach through the cooperative efforts of those who would be most benefited — that is, the engineers whose files already contain data of this sort, but to whom a complete compilation would be of enormous benefit. The editors are enthusiastically behind the plan and will gladly serve as the correlating agency. If you have not read the Eckhardt plan we urge you to do so and let us have the benefit of your opinions. THE EDITORS

CHARLES OWEN BROWN
CHEMICAL ENGINEER

331 Madison Avenue
New York

October 3, 1946

Mr. S. D. Kirkpatrick, Editor,
Chemical Engineering,
330 West 42nd Street
New York 18, New York

My dear Sid:

I have read with a great deal of interest the article by Henry Eckhardt that appeared in your September issue. I think it would be an excellent idea of making a major piece of work out of this suggestion. I believe that it warrants another handbook of the order of Perry's.

Although I have been thinking of devoting a number of articles to an exposition of chemical plant cost data and similar data on operating costs for chemical processes, I think this idea is not as good as the suggestion of Eckhardt, and that it would be much better if a cooperative effort were made to produce a real handbook. Such a book, I think, should be published by McGraw-Hill in view of their excellent past record.

Eckhardt has made a very excellent contribution. It was interesting to me to note his list of seven references on cost data. They emphasize the paucity of this information and confirm the records I have in my office concerning the standard texts available on this subject. Fortunately, my files are a much better source for such information.

Very truly yours,
Chas O. Brown

COB:ew

SOUTHERN ALKALI CORPORATION

CORPUS CHRISTI, TEXAS

October 9, 1946

Mr. Sidney Kirkpatrick
Chemical Engineering
330 W. 42nd St.
New York 18, N. Y.

Subject: Article on Cost Estimating

Dear Sir:

Mr. Eckhardt has done an excellent job of presenting the problem in the September issue. May we look forward to a series of articles presenting the solution of the problem? You may as well set them up so as to run reprints of the series as they are likely to be one of your most popular items.

Mr. Eckhardt's suggestion of tying price estimates to commodity index or something of the sort is very good, but to show up regional inequalities it might be desirable to tie it back to base metal prices and man hours as well as to the commodity or wage scale index.

Since manufacturers are so reluctant to give out prices, you will no doubt be put to some little expense securing satisfactory personnel to get the data; however, we believe the interest would justify all the difficulties encountered.

Very truly yours,
Clayton Stephenson
Chemical Engineer

CS:ej

WAR ASSETS ADMINISTRATION
WASHINGTON 25 D C

October 2, 1946

Mr. S. D. Kirkpatrick, Editor
Chemical Engineering,
McGraw-Hill Building
330 West 42nd Street,
New York, N. Y.

Dear Sid,

The article commencing on Page 104 of your September issue, together with the Editor's invitation for correspondence (and contribution of data), was very interesting to me.

As the author, Mr. Henry Eckhardt, pointed out, the assembly of such data would be extremely valuable, but it does present considerable difficulty.

I would suggest that CHEM & MET ought to encourage such an undertaking and should work out with the author of the article some practicable means of publishing a book or manual.

Is it possible that the American Institute of Chemical Engineers might consider underwriting such a project, after due evaluation of its tremendous worth to the profession and the industry?

Very truly yours,
George Walker
GEORGE WALKER

CHEMICAL ENGINEERS' HANDBOOK

Mr. S. D. Kirkpatrick, Editor,
Chemical Engineering,
330 West 42nd St.,
New York, N. Y.

October 4, 1946

Dear Sid:

I was mighty glad to see the Eckhardt article in your September issue and find that you are trying to do something about this important matter of cost data for process equipment. It is true as Mr. Eckhardt says that we have been able to get data of this sort into some of the sections of the "Chemical Engineers' Handbook" but it is also true that the data are limited.

It is hardly possible to exaggerate the importance of having available accurate cost information for use in estimates dealing with design, construction and operation in the process field. The assembly of truly useful cost data presents great difficulty but I do not believe the difficulties are insurmountable. The goal should be to obtain cost data that can readily be tied to current costs in the same way that general over all construction costs are ratioed by using the well-known construction indices.

In fact, it would be well to consider the possibility of developing a quarterly or annual index (or indices) for chemical process equipment and operating costs. Equipment manufacturers should back such a study while engineers with process engineering experience should be the source of operating data and methods for handling such data.

Very truly yours,
John H. Perry
Editor,
Chemical Engineers' Handbook

Shipley Road,
Wilmington,
Delaware

GENERAL AMERICAN PROCESS EQUIPMENT
DIVISION OF GENERAL AMERICAN TRANSPORTATION CORPORATION
420 LEXINGTON AVENUE
NEW YORK 17, NEW YORK

Mr. S.D. Kirkpatrick,
Editor,
Chemical Engineering,
330 West 42nd Street,
New York 18, N.Y.

October 3, 1946

Dear Sid:

I was very much interested in Mr. Eckhardt's article in the September issue of CHEM & MET and I think it is a fine idea and that you should get behind it and make a start at least toward collecting such data. I shall be glad to be of any possible help.

You will remember that about ten years ago Harrison Howe suggested something of the sort be done and he attempted to collect the costs of various items of equipment and the cost of their operation. Some manufacturers resisted giving out any costs of the various sizes of equipment they built. I imagine many did the same but I cannot see why and I think you should be able to get something together now.

I am sure that when you first started putting out flowsheets there must have been a good deal of objection on the part of many companies to giving you the needed information, but this seems to have been all forgotten and the flowsheets are now a valuable part of our chemical engineering data. I think you will find the same thing true on the cost of pieces of equipment and their cost of operation and if you make a start you will probably find that everyone will fall in line, including the equipment manufacturers.

Sincerely,
GENERAL AMERICAN TRANSPORTATION CORP.
By C.L. Knowles
C.L. Knowles, Technical Director
Process Equipment Division

CLK:wj

THE TURBO-MIXER CORP

LOUISVILLE DRYING MACHINERY CO

AMERICAN MACHINE CO.

GENERAL ANILINE WORKS
ENGINEERING DEPARTMENT
Grasselli, Union County
NEW JERSEY

Factories

October 24, 1946

Mr. S. D. Kirkpatrick,
Chemical Engineering,
330 West 42nd Street
New York 18, New York

Dear Mr. Kirkpatrick:

The statement by Mr. Henry Eckhardt in the September issue of "Chemical Engineering" that there is need for "Standard Cost Estimating Data for the Process Industries" and his suggestion that something be done to meet that need are both very much to the point. If you can interest others in such an undertaking I am sure that we shall be glad to cooperate.

Sincerely yours,
GENERAL ANILINE WORKS,
Engineering Department
D.E. Pierce
D. E. Pierce
Chief Engineer

DEP:ma

Please address your reply to ENGINEERING DEPARTMENT, General Aniline Works, Grasselli, N. J.

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BROOKLYN N.Y.
NEW BRUNSWICK N.J.

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Mr. S. D. Kirkpatrick, Editor,
Chemical Engineering,
330 West 42nd Street,
New York, 18, N. Y.

October 23, 1946.

Dear Mr. Kirkpatrick:

I am gratified by the response to my suggestion in your September issue that a standard cost hand book for the process industries should be established by the cooperative work of all who are interested in this subject.

I note with interest that one manufacturer is willing to cooperate in compiling the proposed standard cost data source. This is progress which should be followed further, since the manufacturers are the primary source for equipment cost data. Perhaps other manufacturers will reconsider their stand on the policy of withholding general price information, in view of the good beginning made in this project.

I am eager to cooperate individually or collectively with those interested in this project, and I look forward to the immediate developments on which we can base our first efforts.

Very truly yours,
Henry Eckhardt
Henry Eckhardt,
Design Engineer,
Engineering Design Dept.

"The 'Priceless Ingredient' of every product is the honor and integrity of its maker."

F. H. CARMAN *General Manager, Plastic Materials Manufacturers Association*

PLASTIC MATERIALS

Review of Supply Outlook

Production of plastics by last August was running about 48 percent above the 1945 rate. Current output of thermoplastic molding powders, not including vinyls, tops that of last year by about 60 percent with thermosetting types increased around 40 percent. Completion of new planned facilities will bring capacities to three and one-half times the 1945 volume.—*Editors*

SINCE THE original forecasts made to the Society of the Plastics Industry in April of this year and in December 1945, many things have happened in the industrial economy which have changed the original plans, delayed expansion programs, and, in a few cases, even required complete alterations in long term constructions. As this is being prepared, labor disputes are causing acute shortages in supply of certain basic raw materials and plastics. The cumulative effects on production since August are extremely serious; even though the labor difficulties are resolved in the near future, the total production lost will not be made up for some time.

In December the Association, speaking for its members, announced a long range expansion program in plastics materials manufacturing in the amount of $107 million to be completed by the middle of 1947. In April of this year a brief review of the situation by Mr. Landes indicated considerable delay in completion of these programs, and it was estimated that increased costs, with which everyone is familiar, make this original estimate of $107 million somewhere around $125 million. Due to strikes in other industries, progress has been disappointingly slow in many cases; costs of construction have become alarmingly high. Nothing has happened since that time to permit earlier completion of these facilities; they have been delayed further. Members report an average delay of four to six months in the original plans; some facilities due early in 1946 will not come in until late in the year and many of the expansions which were to have been completed in 1947 will not be available until 1948.

Increase in costs of many constructions has already been mentioned, the extent over the original $107 million is not available at this time. A number of PMMA members have announced additional expansion programs not previously included in industry estimates. These include certain new materials, additions to existing plants, and will provide further growth of plastics expanded during the war. Roughly these new programs involve expenditures amounting to $21,850,000.

RAW MATERIAL SUPPLIES

Strikes in the coal, steel, and chemical industries have severely curtailed the supply of many basic materials for the plastics industry. Some of the present or pending shortages include:

Phenol—In short supply prior to existing strikes and is now exceedingly tight. Even with elimination of these difficulties, it is estimated the shortage will not be entirely eliminated for six months to a year.

Cresols and Creyslic Acid—Certain pricing policies on coal-tar do not encourage production and, if continued, future supplies will be even less plentiful.

Phthalic Anyhydride—Strikes earlier in the year and others now in force affect supply of this chemical in the same manner as phenol production.

Urea and Formaldehyde—There was no surplus of these chemicals before the coal strike which aggravated the situation. During 1947 it is anticipated the availability of urea and formaldehyde is likely to be a limiting factor in plastics production rather than supply of labor or manufacturing capacity. New production units for both these chemicals should eventually improve this situation.

Glycerine—There is little prospect for supplies easing up before the end of 1947 or even later. The shortage is due primarily to the international shortage of fats and oils and the absence of a normally large supply of copra from the South Pacific.

Plasticizers—Severely curtailed by the aforementioned strikes. Other industries competing for chemicals used in manufacturing the better plasticizers further aggravate the situation. The shortage of good plasticizers actually prevents certain desirable uses of some plastics and diverts the material to less important products. Some manufacturers are prone to resort to inferior plasticizers which may affect the reputation of the industry. Plans are going forward to increase production of certain plasticizer chemicals by the end of 1947. Some industry members predict supplies will be even more critical during 1947 when increased resin production comes in.

Benzol and Alcohol—Important basic materials required by many industries. Benzol supply at the present time is not too plentiful because of lower steel mill operations. As large amounts are required for both phenol and styrene and increased amounts will be needed, it is becoming ever more important for plastics. Alcohol supply has been mentioned as possibly affecting production of certain cellulose plastics.

Cotton Linters—A large portion of the cellulose plastics production is still dependent on cotton. Even with pending price increases, the supply may still be short especially in view of plastics and rayon expansions.

Pigments and Lubricants—Shortages are presently affecting vinyl plastics production.

NITROCELLULOSE PLASTICS

Production in 1945 was 15,235,676 lb. and the 1946 production rate has been 18,400,000 lb. Census reports for the first

Based on paper delivered by Mr. Carman before the New England Section meeting, Society of the Plastics Industry, at Manchester, Vt., on Oct. 18, 1946.

eight months of 1946 indicate this material is being produced at a rate 20 percent greater than in 1945. Incidentally this is the highest rate for pyroxylin plastics since 1937. Even though this was the first plastic material and newer ones have been developed and expanded enormously, the high production rate maintained for this plastic has surprised many in the industry. PMMA members report that availability of nitrocellulose is about equal to demand and it is anticipated there will be little change in this position.

CELLULOSE ESTER PLASTICS

Government reports now indicate that production of sheets, rods, tubes and film in the first eight months is running at a rate 21 percent in excess of 1945 production. Demand for these materials, particularly for continuous sheeting, continues at a high rate. Producers report demand is substantially in excess of supply, with estimates running as high as 3:1 for certain types of material. In the December survey, a short term increase in continuous sheeting was not forecast. However, production now has been increased to the extent already indicated. Consumers can anticipate even better availability of film through expansions to be completed in 1947. Compared with the 1945 rate, PMMA members anticipate an increase amounting to approximately 100 percent.

CELLULOSE ESTER MOLDING POWDER

In 1945 production was 61,123,000 lb. and based on eight months, the 1946 rate is 82,000,000 lb. or an increase of 34 percent. Demand for flake of this type still is in excess of supply with the ratio roughly estimated at 2½:1. Members report the ratio of demand to supply of molding powder is approximately 3:1.

All Cellulose Molding Powders

Production data are shown as percentages of 1939, 1941, and 1945. Last December a short term increase of 6-10 percent and long range increase of 53 percent was forecast.

Base Year as 100

Base Year	1945 Rate	August 1946 Estimated Rate	Estimated Rate After Expansion
1939..........	484	570	745
1941..........	198	234	305
1945..........	...	118	184

POLYSTYRENE PLASTICS

Bureau of Census shows 1945 production as 23,500,000 lb. and based on seven months, 1946 rate is 53,700,000 lb. or an increase of 128 percent. Figures already presented to the Society indicate the 1945 production rate was 32 times that of 1939.

Polystyrene Molding Material

Base Year as 100 *

Base Year	1945 Rate	August 1946 Estimated Rate	Estimated Rate After Expansion
1939..........	3,260	11,130	31,200
1941..........	388	1,040	3,705
1945..........	.....	268	955

The estimated rate by January 1, 1947 is 374 percent of 1945 actual production. Consumers can anticipate increased availability from month to month.

VINYL RESIN PLASTICS

Producers report capacity production on most of the vinyl plastics. Demand for vinylidene chloride, polyvinyl chloride, and copolymer resins and compounds, especially the elastomeric type, are approximately three times the available supply. During the latter part of 1945 full capacity of the industry was not utilized because of reconversion problems. With the change from war to civilian production, the end use pattern changed extensively. Based on Census' reports for seven months the increase this year over the last five months of 1945 is roughly estimated at 50 percent. Other vinyl plastics such as polyvinyl butyral and polyvinyl acetate, although running at higher production rates are believed to be in sufficient supply.

Base Year as 100

Base Year	1945 Rate	August 1946 Estimated Rate	Estimated Rate After Expansion
1939..........	1,250	1,438	3,000
1941..........	373	429	895
1945..........	.....	115	240

Since earlier reports on expansion plans, further increases have been announced for certain vinyl resins.

AMINO MOLDING POWDERS

Producers report near capicity operations for these materials with demand almost four times the availability. Substantial increases in production over 1945 already have been made and further expansions are under way for completion in the latter part of 1947. In December 1945, a forecast of 25 percent increase by April and 80 percent by the latter part of 1946 was made. It is believed the short term expansion has been achieved and that the long term increase will be exceeded.

PHENOLIC MOLDING MATERIALS

Based on the last six months, the 1945 annual rate for production was 119,000,000 lb. while based on seven months, 1946 rate is 151,000,000 lb. and the July 1946 rate is 43 percent over the average for the last half of 1945. These figures show that forecasts made earlier in the year are being exceeded. Acute shortage of materials and labor troubles indicate a decided drop can be anticipated over the remainder of the year.

Base Year as 100

Base Year	1945 Rate	August 1946 Estimated Rate	Estimated Rate After Expansion
1939..........	185	267	334
1941..........	107	154	193
1945..........	...	144	180

MISCELLANEOUS PLASTICS

Production of synthetic resin adhesives, both phenolic and urea, currently is going ahead considerably in excess of 1945. PMMA members report present operations increased from 25 percent to 90 percent over the former period and demand is about one and one-half the supply. Some expansion in manufacturing capacity has been made although definite information is not available. Because of these and additional facilities under contemplation, the industry can rest assured that manufacturing capacity will not seriously curtail production.

Members of the Association report production of acrylic, nylon, polyethylene and other miscellaneous plastics well in excess of 1945 rates. A four-fold expansion has been possible for certain molding materials and substantial capacity brought into operation for other newer materials.

Demands for laminating and industrial resins are somewhat in excess of current supplies even though producers are operating at rates substantially above 1945.

Summary of Plastics Production

Molding Powders
Base year as 100

Thermoplastics Vinyls not included	1945 Rate	August 1946 Estimated Rate	Estimated Rate After Expansion
Based on 1939......	652	1,040	2,340
Based on 1941......	230	360	826
Based on 1945......	...	160	360
Based on Aug. 1946..	...	.....	224
Thermosetting			
Based on 1939	187	262	357
Based on 1941......	110	157	214
Based on 1945......	...	140	192
Based on Aug. 1946..	...	.....	137
All Molding Powders Vinyls not Included			
Based on 1939......	261	386	667
Based on 1941......	140	208	358
Based on 1945......	...	148	256
Based on Aug. 1946..	...	.....	173

Data for thermoplastics molding powders include all materials currently produced by PMMA members with the exception of vinyls.

All Plastics Materials*

Base Year as 100

Base Year	Production 1941	Rate 1945
1939......................	200	364
1941......................	...	182

* Based on government reports. Includes certain synthetic resins for protective coatings and coumarone indene resins.

PMMA Estimates

Base Year	1945 Rate	August 1946 Rate	Estimated Rate After Expansion
1939..........	335	458	656
1941..........	174	238	342
1945..........	...	140	200

FROM THE VIEWPOINT OF THE EDITORS—

AT LAST AN A.E.C.

President Truman's appointment on October 28 of the men to constitute the new Atomic Energy Commission came as welcome news to those who feel it is high time to transfer such activities from military to civilian control. Those selected for these heavy responsibilities are earnest patriotic citizens who may be expected to take seriously their assignments. That only Chairman Lilienthal and Professor Bacher are intimately acquainted with the problems of atomic energy is not a valid criticism of the Board. The point of view of the lay public should be the controlling interest rather than the viewpoints of the scientist or of the military. The job calls for statesmanship of high order and also a lot of hard, conscientious work.

INTER-INDUSTRY COMPETITION

More serious competition often comes to many companies in the process industries from outside their own line of business than is encountered from contemporary firms making identical or similar goods. This is true in other business affairs, also. The railroads worry about waterways and air competition. The coal industry is terrified at the prospect of huge natural gas movement. Inter-industry competition is the order of the day.

Within the field of chemical enterprise we have currently an outstanding set of problems of just this sort. They relate to industrial alcohol. They deserve study far outside the alcohol industry because the problems of that industry can be an object lesson for many others.

Industrial alcohol in the past has been based largely on molasses as a raw material. Now the molasses supply is wholly inadequate, with no attractive prospect for the near future. Substitution of corn or granular wheat flour, practiced during the war period, is closely regulated now, and will probably be unattractive economically for many years to come.

And the alcohol producers are finding that they no longer command the major markets formerly dominated. Methanol is successfully promoted as an anti-freeze. Isopropyl alcohol promises formidable competition. And synthetic ethanol is made not only as an incident to organic chemical business but also as a byproduct of petroleum refining and as a potential co-product of synthetic liquid fuel made from natural gas.

The "natural" industries in the chemical process field have no assurance of permanence. Let us not forget natural indigo, natural camphor, and numerous other natural products no longer important industrially. The executive or engineer who worries about competition from solely within his own industry is not worrying on a large enough scale to keep up with all the headaches of the times.

MILITARY RESEARCH vs. OBSOLESCENT WEAPONS

Last spring General Eisenhower enunciated a new War Department policy on research and development. He wanted to make certain that this country would not make the same mistake we made after World War I of sitting back on a stockpile of obsolescent fighting equipment. "The Armed Forces," he said, "could not have won the war alone. Scientists and business men contributed techniques and weapons which enabled us to outwit and overwhelm the enemy.... This pattern of integration must be translated into a peacetime counterpart which will not merely familiarize the Army with the progress made in science and industry, but draw into our planning for national security all the civilian resources which can contribute to the defense of the country." To carry out this policy of integrating civilian and military resources, the War Department created a Research and Development Division on the highest level of its General Staff with Major General Henry S. Aurand as director.

Some idea of the magnitude of the research and development programs of the Army and Navy may be gained from the fact that the funds available this year are nearly half as great as the funds for actual procurement of weapons and equipment—comparable in total to the entire prewar outlay for industrial expenditures in this field. Furthermore, when recent economy moves were forced by the White House, the services invariably chose to take the cut from the production side rather than in their research programs. Today the limit on developmental contracting is not the availability of funds as much as it is the reluctance of industry to tie up research facilities and personnel on government work.

No one can say today exactly how much "leftover" money the Army and Navy have available to spend on research. Presumably this is one of the motivating considerations behind the appointment on October 17 of a Presidential Research Board with Reconversion Director John R. Steelman as chairman, and to which was given broad instructions "to coordinate and improve the efficiency of all federal research." In President Truman's accompanying statement it was apparent that he is beginning to have some qualms about "the share of our national income which can be devoted to research." He warns "there must be no duplication, overlapping or inefficiency to hamper federal research. In view of the current level of federal expenditures, our research activities must be conducted with minimum expenditures consistent with the essential objectives of a federal program." He expressed his concern "over the current shortage of scientific personnel," and asked the Board to make a careful inquiry into this phase of the national research program.

Undoubtedly there is need for an over-all study of the problems being created by the overlapping programs of the Armed Services. Whether or not the Presidential Research Board as now constituted can arrive at the right answer is open to serious doubt. It is dominated by five cabinet members and the non-technical heads of four or five other governmental agencies. There are only two representatives whose work deals intimately with research. Such a Board may produce little more than some generalizations on which the White House can base its further demands for economy through curtailment of activities for which appropriations have been made. Some corrections of excesses may be necessary, but too drastic action could prove dangerously shortsighted if the Armed Forces are not to be handicapped in their efforts to join military and civilian science for safeguarding national security in this atomic age.

COOPERATION WITH REGULATORS

Not long ago the Civilian Production Administration announced that an Industry Advisory Committee had "adjourned its meeting and requested that no future meetings be called until 'Government pricing inaction on urgently needed raw materials' was ended."

Industry Advisory Committees are supposed to be, as their name implies, advisory to the government organizations which they serve. They are composed of members of industry, presumably representative of the entire cross section of their own fields. Companies not specifically represented by membership on the Committee have ready access to the committee members and certainly every right to present their minority opinions.

Whatever we may think of the action or inaction of any government agency, it seems to us that little is to be gained by deliberately breaking contact with that agency. While we do not know exactly who was involved in the incident that came to our attention, and we have no desire to know their names and connections, we feel that intensified "advice" would perhaps have accomplished more than adjournment. This advice, in the form of factual evidence, should be presented as forcefully and as persuasively as any committee report can be made. It should be documented completely and with care for its accuracy and authority. Decisions of the regulating agency may not follow in exactly the desired pattern, but industry's best advice is then on record.

ELECTION IS OVER

During the next twelve months is the time in which to get government action on business matters. During the rest of this year and most of 1947, Congress and the Executive Departments will be largely free from the urgency of political pressures. They will not be just approaching either primary, Congressional, or Presidential balloting. Thus they can give more fair and factual attention to the decisions which they must make and to the influences which they can properly exert.

If a process industry needs to get clearances or approvals it will be wise to get them soon. Freedom of action by politicians will end a year from now, when they begin to worry about 1948.

CHEMURGIC PLANS BROADENED

Agricultural research on a much broader basis than ever before practiced is authorized by Public Law 733 which was signed by the President during August of this year. This law provides the authority for new appropriations of large magnitude to support the development of industrial products from agricultural materials.

It is expected that nearly $10,000,000 will be appropriated for new projects of this sort to begin in 1947. The principal objective is to anticipate the time when agricultural surpluses may again plague Washington and be ready to afford new industrial outlets that will be sound and constructive, not mere makeshifts or unsound subsidies.

Permitted fields of research include improved farm production methods which may lower costs, development of new crops, studies of human nutrition, and a great variety of other studies long recognized as fundamental for scientific agriculture. Enterprising industry can well take part by encouraging the most promising of the chemurgic studies which are not yet adequately supported or prosecuted. Sooner or later there can be established profitable enterprises based on chemical processing of farm products. The sooner this is done the better for all industries.

The next six months offers an opportunity to exert constructive influence with the Department of Agriculture, and later with Congress, for stimulation of the most promising project of this sort.

ANOTHER "PLUS" FOR THE PACIFIC

For more than twenty years this magazine has maintained active editorial representation on the Pacific Coast. Readers there have reason to remember the long and unselfish services of Dr. Paul D. V. Manning who succeeded Arthur W. Allen in 1926. Hal Smith, now of Bonneville, carried on for a time from Los Angeles until Jan. 1, 1945 when John R. Callaham, associate editor, was transferred to our San Francisco office. Now, as is announced elsewhere in this issue, his hand is to be strengthened by the employment of James Cosgrave as his editorial assistant. All this is in anticipation of additional services and coverage of the rapidly developing West.

Beginning next January the section of *Chemical Engineering* which since 1945 has been called "Pacific Process Industries" will concentrate on news of local events and regional developments of primary interest to western readers while trends and progress of national concern will be reported more adequately in articles and the other departments of the magazine. Thus there will be a "plus value" of editorial service in the Pacific Edition to subscribers residing in the eleven western states, at the same time the National Edition will be strengthened by increased coverage and more comprehensive reporting of developments that affect the economy and profession as a whole. If the program succeeds, as we believe it will, we may well look forward to additional opportunities in the future to serve other rapidly developing areas in which special attention to local and regional news will help to advance the common interests and objectives of all American chemical engineers.

CHEMICAL ENGINEERING PLANT NOTEBOOK—

THEODORE R. OLIVE, Associate Editor

$50 CASH PRIZE FOR A GOOD IDEA!

Until further notice the editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the "*Chemical Engineering Plant Notebook*." The winner each month will be announced in the issue of the next month: e.g., the November winner will be announced in December, and his article published in January. Judges will be the editors of *Chemical Engineering*. Non-winning articles submitted for this contest will be published if acceptable, in that case being paid for at applicable space rates. (Right is reserved to make no award if no article received is of award status.)

Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible. Neither finished drawings nor polished writing are necessary, since only appropriateness, novelty and usefulness of the ideas presented are considered.

Articles may deal with any sort of plant or production "kink" or shortcut that will be of interest to chemical engineers in the process industries. In addition, novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

OCTOBER WINNER!

A prize of $50 in cash will be issued to

A. A. LYNCH and M. W. ROSCH
American Cyanamid Co.
Stamford, Conn.

For an article dealing with a method of avoiding heat loss from a process vessel jacket that has been judged the winner of our October contest.

This article will appear in our December issue. Watch for it!

September Contest Prize Winner

DYE INSOLUBLE IN ONE COMPONENT PERMITS VISUAL STUDY OF PACKING CHANNELING

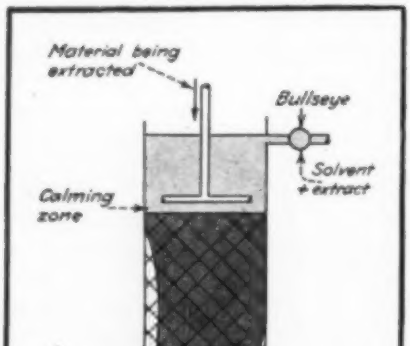
G. V. O'CONNOR
Evans Chemetics, Inc.
Waterloo, N. Y.

In evaluating various types of packing for distillation and extraction columns the question of possible channeling is always present and may introduce an error that cannot be measured. In a recent problem in extraction the extent of the channeling was of prime importance and it was necessary to choose the type of packing which would minimize this effect.

Since both the solvent used and the liquid to be extracted were colorless, visual inspection of the Pyrex glass laboratory column would give no inkling of the behavior of the packing in question. However, the problem was quickly and easily solved by adding a dye that was insoluble in water, but was soluble in the solvent employed. By this device it was possible not only to observe the dispersion of the solvent through the raffinate at all points in the tower, but also to study the behavior of the solvent as it emerged from the spargers. Thus types of both spargers and packing could be varied until the optimum conditions were obtained.

The same scheme could also be used, of course, with a water-soluble, solvent-insoluble dye. In addition, it is possible to make use of the opacity of the dye-containing solvent for photo-electric control. For example, a bullseye can be installed in the solvent discharge line and a light source and photo-cell arranged to actuate a valve. Here, if the raffinate level in the tower should increase until clear liquid rather than opaque solvent ran from the discharge line, then the photo-cell would operate to close a valve and ring a warning.

Use of a dye soluble in the solvent but not in the raffinate enables channeling to be studied visually



HOW A GAS HOLDER WAS PATCHED DURING USE

R. H. SCHALLER
Aliquippa, Pa.

The method described here for welding a patch on to a gas holder while the holder is in operation has been used successfully by the writer in putting three patches on one holder.

First test the holder plate around the leak with a small hammer to determine the plate thickness, so that the proper size of patch can be judged. Then cut a patch to fit over the leak, shaping it to a slightly smaller radius than the holder so the edges will pull up tight. The patch should then be provided with a ¾-in. pipe connection at its center which is used to bleed away the leaking gas during welding, and is afterwards plugged. This can best be made by cutting a ¾-in. pipe coupling in half and welding it to the outer side of the patch plate concentric with a hole drilled through the center of the plate. Care should be taken to see that the threads are in good condition.

It is now necessary to provide a gas-tight gasket near the outer edge of the patch. For this purpose apply a strip of thick shellac to the back side of the patch and place a strip of lamp wick over the shellac, shellacing over the wick.

To hold the patch in place while it is being welded, stretch a small cable around the holder horizontally at leak level, providing it with a turnbuckle to supply tension. Place the patch on the holder under the cable, tighten the turnbuckle and drive two wooden wedges, one from the bottom

and one from the top, between the patch and the cable. This should give a tight joint around the outer edge of the patch, bleeding the leaking gas out through the pipe coupling. To remove the gas, screw a pipe nipple into the coupling and attach a 20-25 ft. length of hose to the nipple to lead the leaking gas to a safe distance.

The patch is now ready to weld. It should first be task welded, then welded all the way around. To complete the job, remove the cable, hose and nipple, screw in a pipe plug, saw off the part of the plug that projects beyond the coupling and finally paint the patch.

NOMOGRAPH FINDS PROPORTIONS FOR ETHANOL-WATER MIXES

WILLIAM C. FRISHE
Professor of Chemical Engineering & Metallurgy
Grove City College
Grove City, Pa.

Ethanol-water solutions are ordinarily made up by pumping 95 percent ethanol from storage tank or drum into the makeup tank which contains water or a dilute solution of ethanol in water. The determination of the final volume of solution for a given final concentration requires temperature and gravity measurements and looking up densities in a handbook. By means of the nomograph given here, however, one can determine quickly the final volume of solution if he knows (1) the initial volume of weak solution; (2) the weak solution concentration; and (3) the final concentration to be made up.

In the example shown on the chart: If 95 percent ethanol is to be added to 50 gal. of water (0 percent ethanol) and the final solution concentration is to be 75 percent ethanol, what will the final volume be?

Connect the initial concentration (C_1) at 0 with final concentration (C_2) at 75. Connect the intersection on the pivot line Z with 50 on the initial volume (V_1) scale. Read the answer, 277 gal., on the final volume (V_2) scale.

It is assumed that mixing will be complete and that the initial and final temperatures will be the same between 10 and 30 deg. C. Obviously the chart can be used also to find the final concentration if the final volume, initial volume and the initial concentration are known.

The chart is based on data for 20 deg. C. from Perry's "Chemical Engineers' Handbook," 2nd edition, p. 441 (McGraw-Hill Book Co., New York, 1941).

CHART FOR CRITICAL PRESSURE OF ANY SUBSTANCE

I. J. HOOKS and FRANK KERZE, JR.
Department of Chemical Engineering
New York University
New York 53, N. Y.

Critical pressure of any substance may be estimated by the equation[1]

$$P_c = \frac{20.8\ T_c}{v_c - 8}$$

where P_c = critical pressure in atmospheres; T_c = critical temperature, deg. K.; and v_c = critical volume, cc. per gram mol.

For most non-associated substances the calculated values for P_c are within 10 percent of the experimental values and the deviation ranges to about 15 percent for associated substances. Use of the nomograph is illustrated for diethylamine, where T_c = 496.6 deg. K. and v_c = 297 cc. per gram mol. The line through these points gives P_c = 35.8 atm., which is close to the experimental value of 36.2 atm.

If v_c is not known it may be obtained by the equation[1]

$$v_c = (0.377\ \overline{P} + 11.0)^{1.25}$$

where $\overline{P}$ is Sugden's parachor, liquid mol volume at standard surface tension. This equation is solved by the double scales at the right of the nomograph, so that the parachor value may be used instead of v_c. The calculated v_c values are generally within 5 percent of the experimental values except for water and diphenyl.

The parachor may be estimated from the table appearing in the upper part of the nomograph by summation of the fundamental values listed. For illustration, we will use the same compound mentioned above. Here, from the table, if the value for C_4 = 19.2; for H_{11} = 188.1; and for N = 12.5, then the parachor for diethylamine = the sum, or 219.8.

The adjacent scale value v_c = 292 compares favorably with the experimental value given above. In the case of associated liquids the parachor should be based on the non-associated structure. Use of the table is not recommended for the simpler gases.

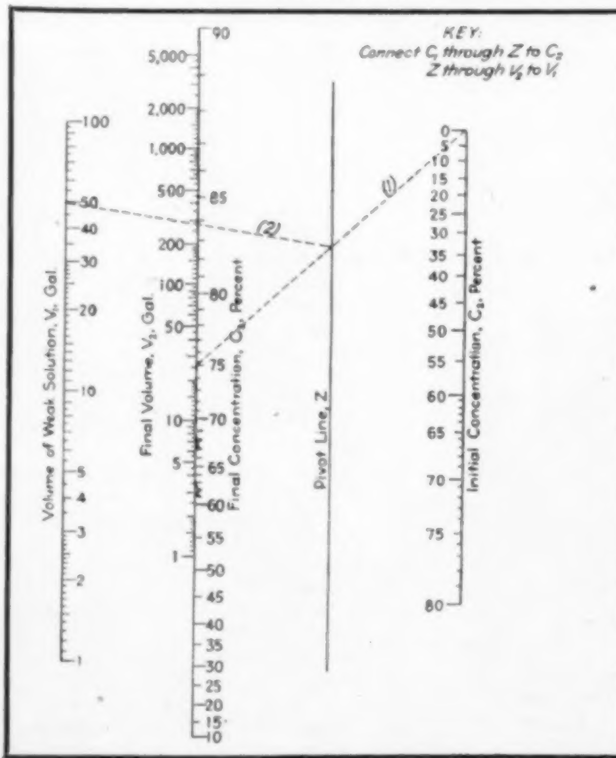
If T_c is not known it may be obtained readily by several methods for which nomographs[2] are available.

REFERENCES

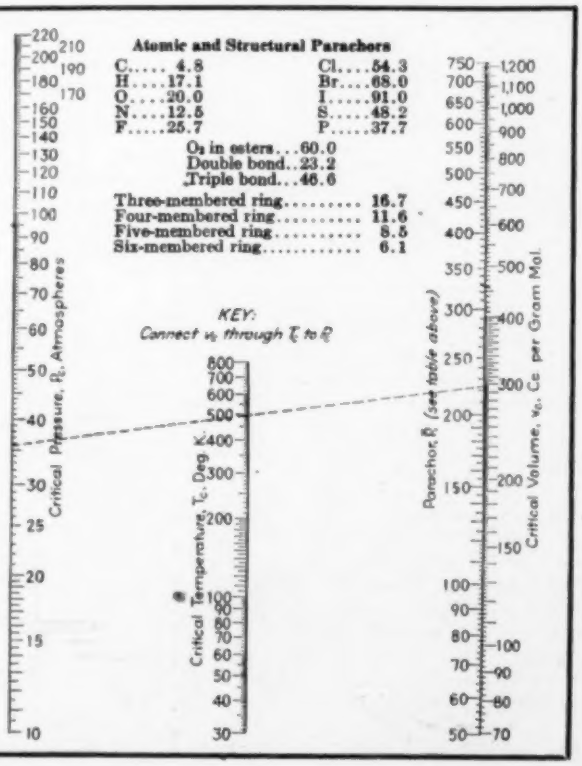
1. Meissner, H. P., and Redding, E. M., *Ind. Eng. Chem.*, 34, 521 (1942).

2. *Chem. & Met.* "Plant Notebook," June 1945, May 1946.

Nomograph solves volume-concentration relations for ethanol-water solutions



Nomograph permits estimation of critical pressure for any substance



PROCESS EQUIPMENT NEWS

THEODORE R. OLIVE, Associate Editor

ALL-METAL THERMOMETER

INDICATION of the maximum or minimum temperatures reached is possible with the new all-metal Max-Min thermometer now being offered by Weston Electrical Instrument Corp., Newark, N. J. Although it is similar in other respects to this company's standard all-metal thermometers, the new type has an auxiliary red index which is manually set by a finger knob protruding from the center of the scale glass. If a record of the lowest temperature reached is desired, this index is placed to the low side of the temperature pointer and the pointer will move the index to the lowest temperature reached. It then remains there until manually re-set. Similarly, for a record of highest temperature reached, the index is set at the high side of the pointer. This thermometer is available in two types having scale diameters of 3 and 5 in., respectively, and is built in all the usual ranges offered by this company.

HOT-PROCESS SOFTENER

DEVELOPED by the Permutit Co., 330 West 42d St., New York 18, N. Y., a new type of hot-process water softener incorporating a sludge blanket design is said to improve boiler feed water and at the same time give substantial savings in chemicals. Other advantages claimed for the the four models of the new softener are reduction in turbidity of soft water, reduced load on the filters, less backwashing, and less silica left in the water.

In the tank, suspended sludge forms a bed which acts as a filter screen for fine particles. Action of this bed, coupled with the slow rate of upward flow of treated water throughout the full cross section of the settling tank, is said to give an effluent lower in turbidity than is obtainable in older types of softeners. Furthermore, when water is softened in two stages, the lower turbidity of the first-stage product reduces phosphate consumption in the second stage. The sludge blanket also decreases lime requirements since the unconsumed lime is retained in the blanket until it reacts with water hardness. Finally, the sludge blanket (when it has considerable oxide or hydroxide of magnesium) gives a higher degree of silica removal than formerly possible owing to increased time and intimacy of contact of silica particles with the magnesium. The height of the sludge blanket is automatically controlled by a photoelectric turbidity detector which automatically blows the unit down through a desludging valve as often as may be needed.

TEMPERATURE CONTROLLER

ON-AND-OFF temperature control, with variation as low as 0.2 deg. F., and power "on-off" cycles as short as three seconds is claimed for the new Xactline temperature controller made by Claud S. Gordon Co., 3000 South Wallace St., Chicago 16, Ill. The unit, which is of the electronic type, employs no cams, motors, bearings, shafts, gears or other rotating mechanical parts and can be employed for all types of electric furnaces, ovens, or injection molding machines employing conventional millivoltmeter and potentiometer type controller pyrometers. It also is applicable to gas-fired equipment employing solenoid-controlled or motor-operated valves.

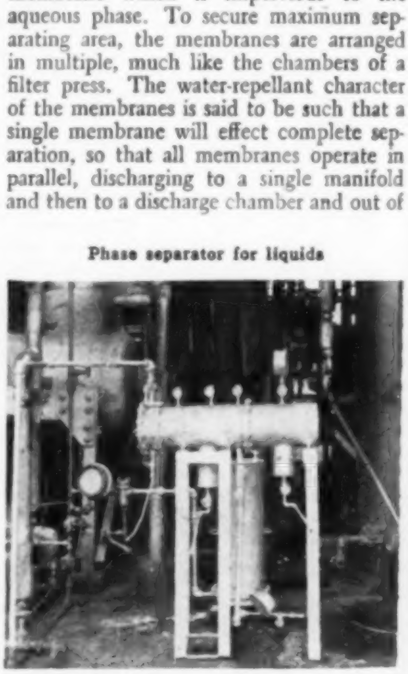
LIQUID SEPARATOR

FOLLOWING several years of experimental work, the Selas Corp. of America, Erie Ave. and D St., Philadelphia 34, Pa., has now introduced a pilot plant and small production model of its phase separator for immiscible liquids. A device of this type, shown used in connection with a steam distillation operation, appears in the accompanying illustration. The device has no moving parts, no packing glands, no space-consuming settling tank, yet is said to be successful in breaking emulsions on steam distillation streams, on phase separation of water from carbon tetrachloride, gasoline, fuel oil, benzol and other organic liquids.

Essentially the separator consists of two parts, a coalescing chamber which houses the coalescing medium, and a separatory chamber in which the separatory membranes are contained. The feed stream first enters the coalescing chamber, shown at the right in the illustration, where its velocity is greatly reduced, allowing finely dispersed particles to coalesce into droplets and settle into the outlet leg for discharge. Coalescence is accelerated by a coalescing medium through which the liquid mixture must flow before it can reach the separatory chamber.

In the separating chamber the remaining aqueous phase is completely separated from the continuous hydrocarbon phase as the latter passes through a preferentially-wetted membrane which is impervious to the aqueous phase. To secure maximum separating area, the membranes are arranged in multiple, much like the chambers of a filter press. The water-repellant character of the membranes is said to be such that a single membrane will effect complete separation, so that all membranes operate in parallel, discharging to a single manifold and then to a discharge chamber and out of

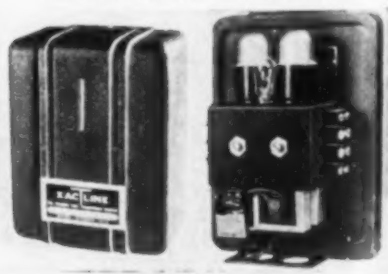
Phase separator for liquids



Sludge-blanket hot process water softener

Thermometer shows maximum or minimum temperature

Electronic temperature controller



the apparatus. The aqueous phase settles into a second outlet leg. Other arrangements are available in case the ejected phase is the lighter liquid, rather than the heavier as described.

GRAVITY CONVEYOR SWITCH

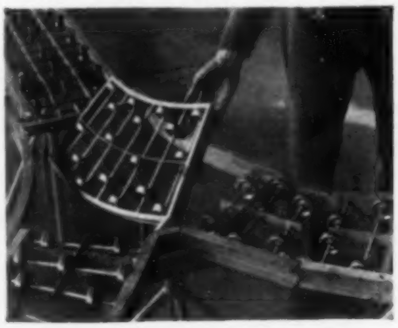
Known as the "Y" Flipswitch, a new switching device for gravity conveyors of the ball-bearing wheel type has been announced by Speedways Conveyors, Inc., 1261 Niagara St., Buffalo 13, N. Y. The new device not only speeds up loading and unloading of materials by making double production lines easy to use and control, but it requires no power and is said to minimize upkeep and maintenance. The principle is clearly evident from the accompanying illustration which shows a curved section of conveyor hinged in such a manner in the center of the switch section that it can be flipped to form a continuous path to either branch of the Y. The device, which weighs only 35 lb., is available for 12, 15 or 18 in. wide standard conveyors made by this company.

HIGH VACUUM GAGE

Ability to cover the vacuum range from millimeters to microns, without danger of burning out the measuring instruments, is incorporated in a new vacuum measuring gage designed for continuous operation at pressures as low as 0.1 micron and introduced by the Scientific Instrument Section of RCA Victor Division, Radio Corporation of America, Camden, N. J. Designated as Type EMG, the instrument incorporates two types of gage, a thermocouple gage for the higher pressure range, and a discharge gage for the lower. The thermocouple gage is housed in an all-metal inclosure to prevent accidental mechanical damage. The discharge gage is of a novel cold-cathode type operating on the ionization principle to give current indications proportional to very low pressures. It contains no filament to burn out. The tube is inclosed in an oval shell. A permanent magnet surrounding the unit induces a strong magnetic field along the minor diameter of the shell, establishing it as the cathode of the gage. The anode consists of a rectangular loop of wire embracing the maximum position of the magnetic field.

These sensitive elements are shown in the foreground of the accompanying view, with the thermocouple gage at the left and the discharge gage at the right.

New "Y" Flipswitch for gravity conveyors



Non-burn-out high vacuum gage

INTERPOLATING CHARTS

Four loose-leaf sheets of durable material, 8½ x 11 in., and punched to fit all binders, are being provided by F. R. Gerber, 1305 S. W. 12th Ave., Portland 1, Ore., to provide automatic interpolation as well as short-cut calculating machine methods of single and double interpolating; condensed seven-place tables of trigonometric functions; and a variety of tables of physical constants, equivalents, etc. The only auxiliary is a carefully calibrated "interpolating tape." Two methods of interpolating are covered, the ordinary "straight-line" method, which, however, is accomplished without any need for calculation; and interpolation in curved functions where ordinary straight-line interpolation is insufficient due to rapidly changing tabular differences. By this method a straight-line interpolation is corrected by means of an alignment chart by applying the method of point second differences. The charts are said to be particularly useful to anyone who uses or constructs numerical tables.

ELECTRONIC HEATER

Experimental work is facilitated by a new electronic heating generator known as Ther-Monic M 285C, now being offered by the Induction Heating Corp., 389 Lafayette St., New York 3, N. Y. The unusual feature of this generator is that it is suitable for providing heat either by the dielectric method or by the induction method. The generator is provided with two separate, interchangeable oscillator sections to permit the two types of heating, changeover from one section to the other being a simple job which is accomplished by removing one oscillator section and replacing it with the other.

The unit operates on 205-245 volts, single-phase a.c., and has a full load input of 12 kva. At 90 percent power factor, its full load output is 285 B.t.u. per min. or approximately 5 kw. at nominal frequencies of 375,000 cycles per second for induction heating and 20,000,000 cycles per second for dielectric heating operations. When operating as a dielectric unit, the device heats non-conducting materials whereas, used as an induction unit, it heats conductors such as metals. Weight of the generator is 1,400 lb. and its dimensions are 36 x 28 x 62 ½ in. high.

Mines Florida Phosphate

This huge Bucyrus-Erie walking dragline excavator, which is being used in the Peace Valley phosphate operations of the International Minerals & Chemical Corp. at Mulberry, Fla., is capable of excavating nearly 2,000 tons of overburden per hour. It can dig to a depth of about 130 ft. and can carry its 64,200-lb. rock load 420 ft. to the dumping spot, each cycle requiring only one minute. It is powered with 46 Westinghouse motors totalling 2,100 hp., variable voltage d.c. drive being used for its drag, hoist and swing motions. Employing a Rototrol rotating type regulator for these motions, the machine has extremely rapid acceleration and deceleration.

HEATING SYSTEM

For heating applications requiring the high temperatures and close control obtainable with Dowtherm, but which do not justify the installation of a Dowtherm boiler, Blaw-Knox Division of Blaw-Knox Co., Box 1198, Pittsburgh, Pa., has developed the Electro-Vapor system. In this system the process vessel is provided with an over sized jacket which serves as a Dowtherm boiler; and a number of electric bayonet heaters which serve to boil the Dowtherm. The system is said to provide uniform heat which can be closely controlled at any temperature between 100 and 700 deg. F. Explosion resistant construction is employed which is said to be safe in hazardous atmospheres.

IMPULSE SCALER

For the counting of beta particles and gamma rays in radioactivity work, Instrument Development Laboratories, 817 East 55th St., Chicago 15, Ill., has introduced the new Model 161 impulse scaler which operates on impulses from a Geiger-Mueller tube and actuates an external register once for each 64 impulses it receives. The instrument has a self-contained high voltage supply and requires no pre-amplifier for use with a Geiger-Mueller tube. This high voltage power supply is electronically regu-

Combination induction and dielectric generator

lated to better than 0.01 percent, per 1 percent change in line voltage. The instrument is said to be simple to operate, either by trained or inexperienced personel.

OXYGEN INDICATOR

Newest in the line of gas-detecting and measuring instruments made by Mine Safety Appliances, Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Pa., is the Type C oxygen indicator designed for indication and control in chemical and petroleum processes and in gas transmission and distribution. The device employs an electrolytic detector cell made up of a plastic container with a hollow carbon tube and metallic plate serving as electrodes in about 1 oz. of liquid electrolyte. Polarization in the cell causes hydrogen to be deposited on the carbon pole. When a gas sample containing oxygen is passed through the hollow carbon electrode, diffusion through the porous carbon causes the oxygen to combine with the hydrogen on the carbon, reducing the internal resistance of the cell and causing its current and voltage output to be increased. A direct reading meter having a linear scale indicates the percentage of oxygen in the sample.

The device is available for full-scale ranges of zero to 0.5, zero to 5, zero to 10, and zero to 25 percent. An adjustable high-point contacting device can be used for automatic operation of warning signals or control circuits.

A sample flow of 25-75 c.c. per min. propelled by an external motor-driven pump operates the instrument. Provision is made for both calibration and zero-adjusting circuits, independent of each other, while an electronic recorder or galvanometer potentiometer recorder can be added if needed.

FLUE GAS RECORDER

Changes in CO_2 content of flue gases can be recorded within 3½ seconds after the changed gas reaches the analyzing cell in the new Davis-Hebler recorder announced by Davis Emergency Equipment Co., 98 Halleck St., Newark 4, N. J. In order still further to increase the speed with which changes are detected, the analyzing cell is located close to the stack so that the changed percentage is indicated almost as soon as it occurs in the stack, according to the manufacturer. In addition to this extreme sensitivity, the new instrument embodies other important features. Operating on the thermal conductivity principle, the instrument eliminates continuously operating suction pumps, employing a flow rate through the gas sampling line of not more than 250 c.c. per min. Filtering trains and dryers are eliminated, with condensate and other harmful substances automatically expelled from the sampling line. Flow through the analyzing cell is produced by the pressure differential between the last pass of the boiler and the stack.

IMPROVED ABRASIVE PUMP

Several improvements in its Hydroseal centrifugal pump for the handling of abrasive materials have been introduced by Allen-Sherman-Hoff Co., 1439 Locust St., Philadelphia 2, Pa. Among these are new heavy-duty, antifriction radial and thrust bearings which are interchangeable and are now standard with these pumps. A new means of axial adjustment for the shaft bearing assembly is provided and a new pump shell which is now supported from the bearing housing in such a way as to permit the pump discharge to be placed in any of three positions including vertical upward, horizontal at top, or horizontal at bottom. This feature usually simplifies installation of discharge piping and eliminates the need for special pump construction. The pump retains its Hydroseal principle and Maximix rubber lining.

NEW CENTRIFUGAL PUMP

Two new lines of pumping equipment developed recently by Warren Steam Pump Co., Warren, Mass., include the Type DBL single-stage, double-suction centrifugal pump, and the Type CH two-stage, high-head, close-coupled centrifugal pump, known as the Compacunit. The first of these is available in capacities from 50 to 600 g.p.m. for heads of 120 to 260 ft., and discharge sizes from 1½ to 3 in. The pump is normally bronze fitted but may be supplied in special metals if desired. The design is said to minimize maintenance and to emphasize accessibility, without the use of special tools. The second type of pump, produced in capacities of from 5 to 300 g.p.m., for heads from 225 to 500 ft., is available for either motor or turbine drive, with either open or closed impellers. The unit is said to be as compact as practicable.

DRY PRODUCT WEIGHER

An improved line of automatic and semi-automatic machines for weighing and filling dry products into containers has been announced by Triangle Package Machinery Co., 906 North Spalding Ave., Chicago 51, Ill. Known as the Triangle Model A Elec-Tri-Pak vibratory feed weighers, these devices are said to be not only more accurate but to package 25 to 50 percent faster than earlier models. The production range is from 15 to 20 packages per minute to as high as 120, depending on the machine and the product. Weighing and discharge of material are automatic except that in the case of bags, rather than rigid containers, an operator must place each bag on the filling spout. The material to be packaged is discharged by electrically vibrated feed plates into a power-rotated weighing receptacle which discharges into the container as soon as the load reaches correct weight. Feeding speed is regulated readily. Some models will weigh as little as ¼ oz. up to 8 oz., with others ranging from 4 oz. to 5 lb. Weight adjustments can readily be made, with minor corrections during operation.

Weigher-filler for dry products

HIGH PRESSURE PUMP

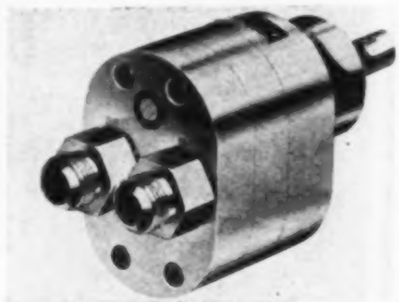
Applications such as power transmission and materials handling, requiring small fluid displacement capacities at high pressure, are the field for the Series 700 pump recently announced by the McIntyre Co., Newton, Mass. This is a direct-driven spur-gear pump said to have a volumetric efficiency in excess of 90 percent and a mechanical efficiency in excess of 80 percent. Four models are available, displacing from 0.4 to 9.6 g.p.m. at speeds ranging up to 1,750 r.p.m., against working pressures up to 1,000 psi. Power requirements range from fractional to 6½ hp. The pump body is constructed of aluminum with nitrided Nitralloy gears.

CARTON PRINTER

Ready imprinting of corrugated cartons, wooden boxes or barrel tops is possible with the new Markomatic industrial printer developed by Adolph Gottscho, Inc., 1 Hudson St., New York 13, N. Y. The device is adjustable to handle several carton sizes and may mark up to 6x9 in. or 5x13. It is manually operated and can mark 300 cases or more per hour, depending on case size and the ability of the operator. Several different models are available to handle different kinds of package.

Correction: In the description of the low-speed tachometer given on p. 138 of our October 1946 issue the name of the manufacturer was inadvertently omitted. The instrument is offered by Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

High pressure gear pump



Industrial printer for cartons

CONTINUOUS SEPARATION OF FATTY ACIDS

Continuous separation of distilled fatty acids into solid and liquid components is carried out in Cincinnati plants of Emery Industries, Inc., one of which is shown above.

A PROCESS for the continuous separation of distilled fatty acids into solids and liquid components has been developed by Emery Industries, Inc., of Cincinnati, Ohio, and has been designated as the Emersol Process. Three commercial plants are now being operated by the Ohio organization, the most recent of which was designed and constructed by the Blaw-Knox Co. of Pittsburgh.

The process may be used to separate the solid and liquid fatty acids from almost any fat or oil. By paying particular attention to the type of feed stock and its preliminary treatment, the plant can operate continuously and produce the products of a desired grade. Typical of the fatty acids which are processed through this equipment are tallow, grease, stearine, and garbage grease. The resulting stearic and oleic acids from any of these fatty acids have similar iodine values and titers but the percentages of stearic and oleic acids resulting, of course depend upon the percentages of the fats in the feed.

The Emersol Process consists essentially of controlled cystallization of solid fatty acids from polar solvent medium, permitting a sharp separation in a single stage. The solvent is separated from the stearic and oleic acids by distillation and is returned for reuse.

In commercial operation, the distilled fatty acid mixture is dissolved in methyl alcohol of proper concentration, along with small amounts of a crystal promoter. This solution is chilled in a multi-tubular agitated crystallizer, resulting in a slurry containing stearic acid crystals and in suspension. This mixture is separated on a continuous rotary filter with cold alcohol to remove adhering liquid acids. The filter cake, consisting of about 50 percent stearic acid and 50 percent solvent, is melted and transferred to a still where the alcohol is removed and returned to the start of the process. The stearic acid is discharged as a final product ready for finishing and packaging.

The filtered oleic acid solution is pumped through an economizer and then to a still where the solvent is recovered. Oleic acid is discharged into commercial grades suitable for industrial application. If it is desired to produce an extra quality product, the acid may be further treated by distillation, washing and bleaching.

Typical Results From a Standard 30 Tons Per Day Plant

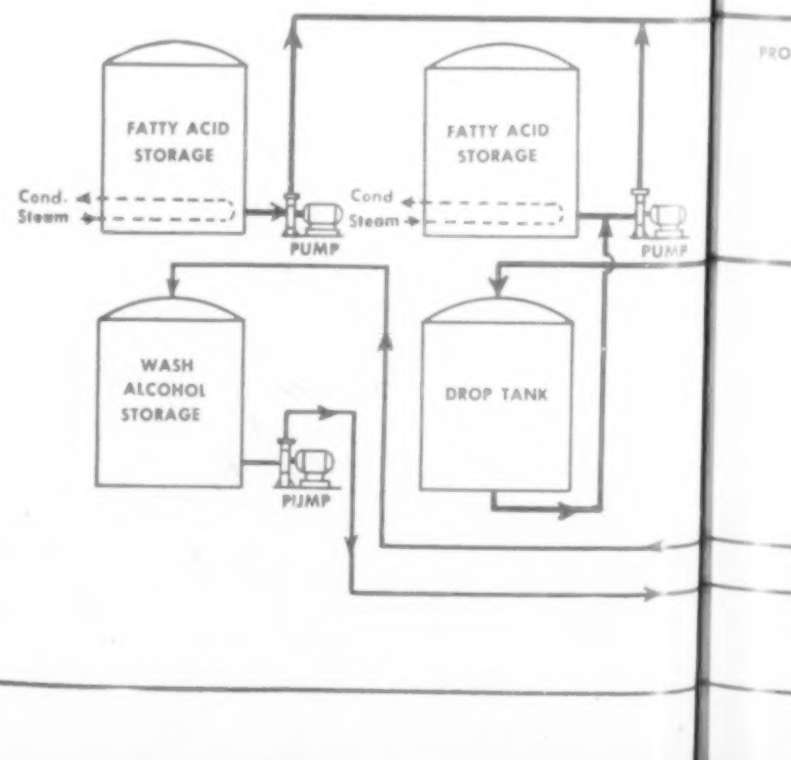
Fatty acid throughput per mo., 1,983,200 lb.

Yield per mo., stearic acid 41.7%, oleic 58.3%

Solvent separation costs per 1,000 lb. exclusive of repairs, depreciation, taxes, insurance, laboratory and general factory expenses were:

Labor	0.76 hr.	Electricity	22.6 k.w.h.
Methanol	7.5 lb.	Water	40 cu.ft.

Steam 3,500 lb.



CHEMICAL ENGINEERING

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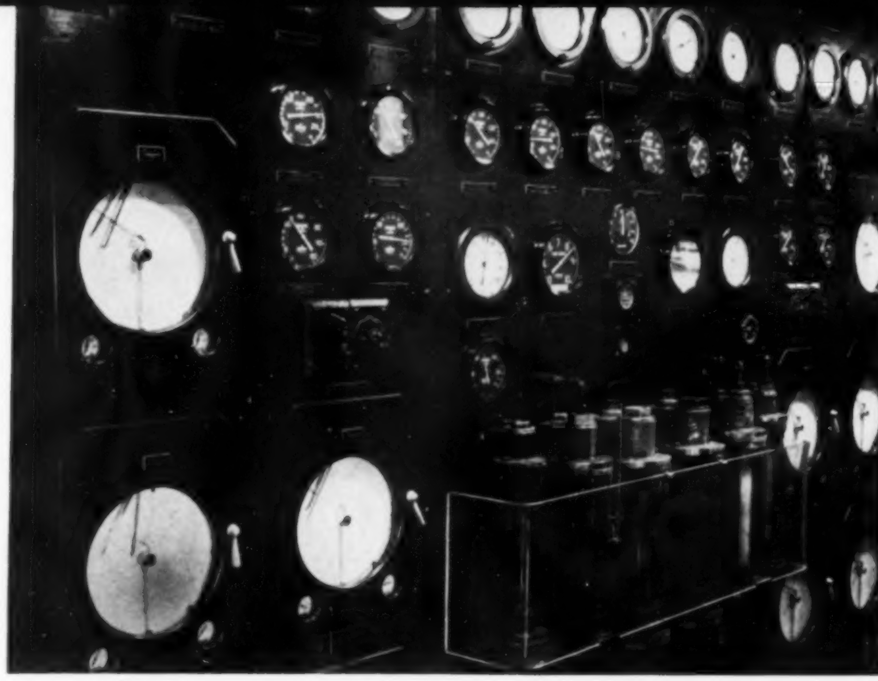
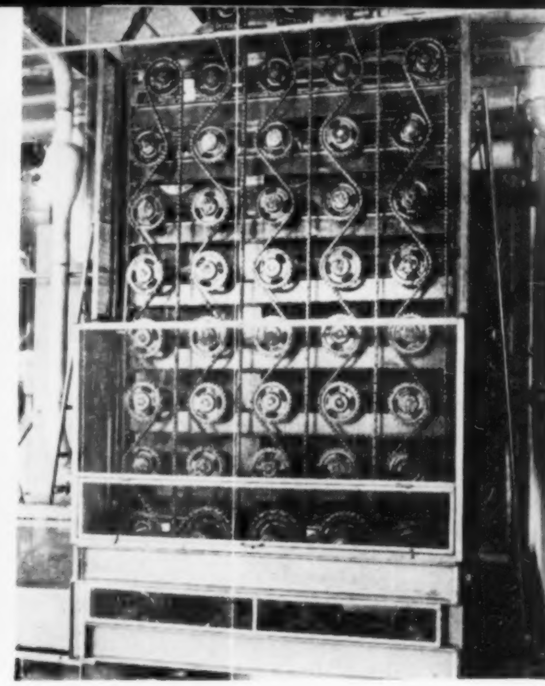
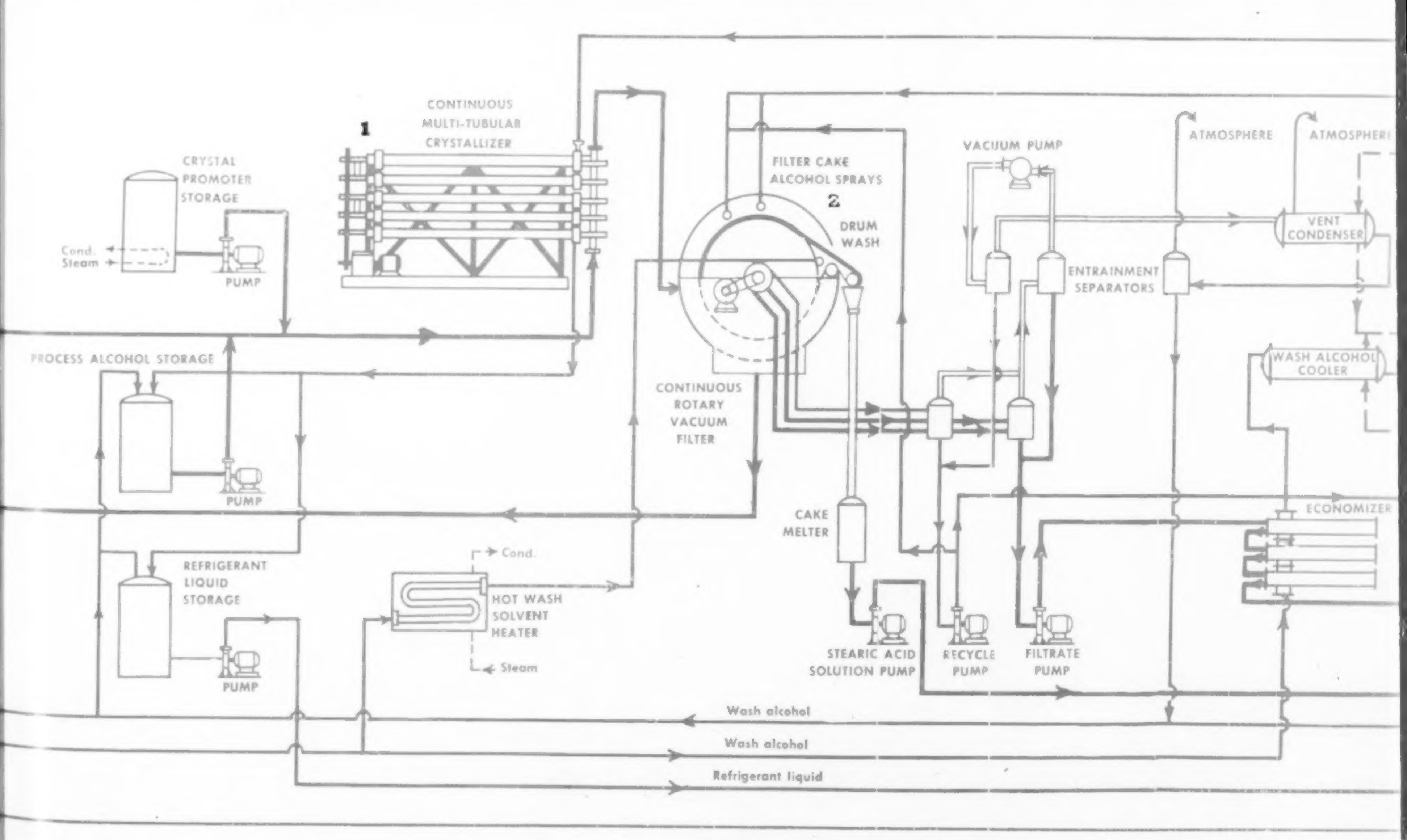


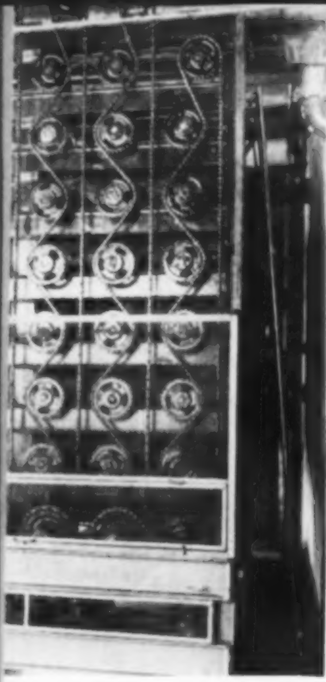
Process consists essentially of controlled crystallization of solid fatty acids from polar solvent medium, permitting a sharp separation in a single stage. It is controlled from a central instrument panel by single operator



1 Fatty acid-solvent mixture chilled in a multi-tubular crystallizer which is driven through an ingenious chain arrangement by a single motor

2 Crystallized st
which is installe
percent stearic a





mixture chilled in a multi-
which is driven through an
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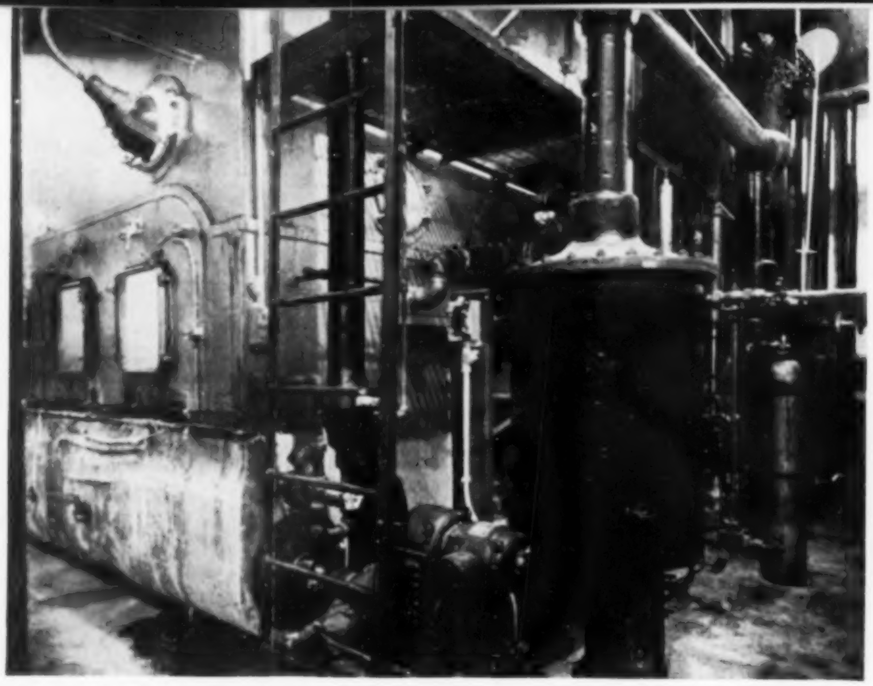
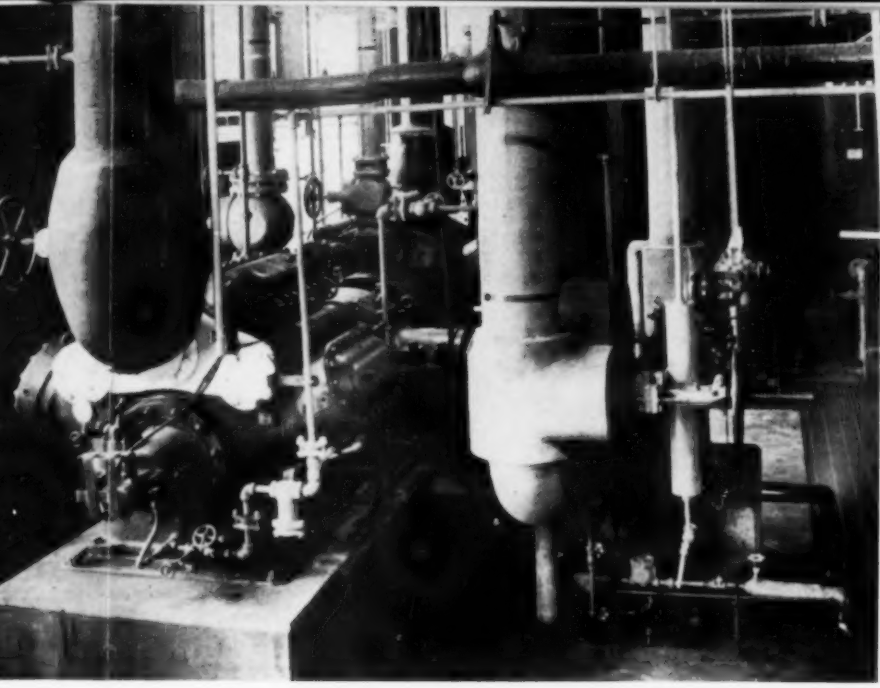


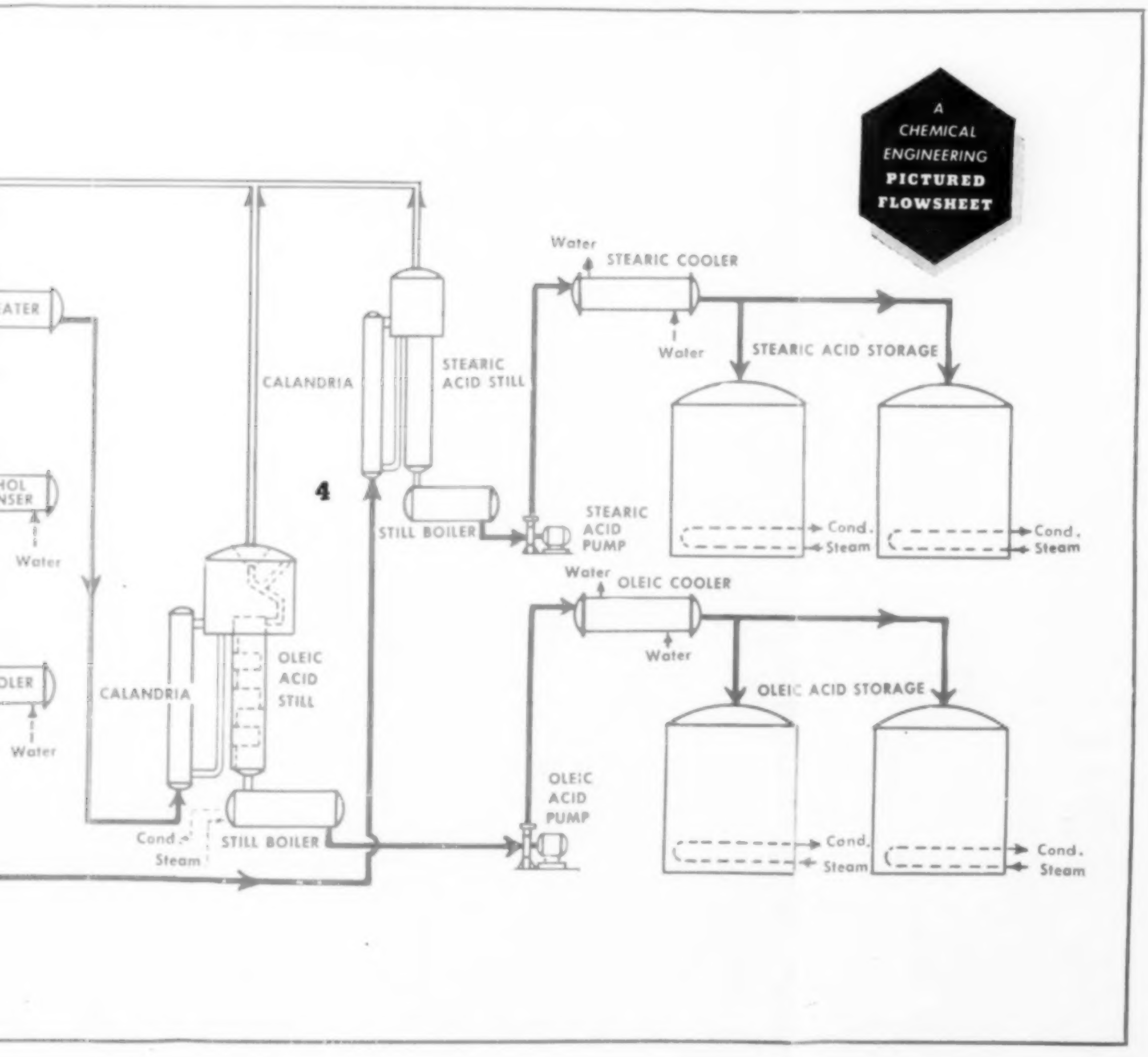
2 Crystallized stearic acid is separated and washed on enclosed vacuum filter which is installed in an insulated cold room. Filter cake consists of about 50 percent stearic acid and 50 percent solvent

3 Refrigeratio
stage ammonia
heat throughou



Refrigeration for operating crystallizer and cold room is obtained with a two-
ge ammonia machine driven by a steam turbine. Exhaust is used for process
t throughout the Emersol plant

4 Solvent is continuously removed from separated stearic and oleic acids in three stills and returned to process for reuse



It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
325 WILSON, SO. NORWALK, CONN.

Girdler's complete service expedites the answer to your Gas Processing problem

If you need a gas processing plant, your worries are over when you give the job to GIRDLER.

From principle to practice—from laboratory work until the plant is in operation and you know all about how to use it—this qualified, responsible organization handles every step of the job. There are no missing links. The entire job is done right, in the right time, at a fair price.

For example . . . the Girbotol Process for removal and recovery of the acidic gases . . . GIRDLER originated it in principle. And, following through with outstanding engineering achievements in the field, GIRDLER has built more actual plants of this type than any other organization.

GIRDLER'S complete follow-through applies to all industrial gas processes.

GIRDLER-planned and GIRDLER-built gas processing plants serve most of the big names in industry.

This includes processes for gas manufacture, purification, separation, and dehydration—processes involving hydrogen sulphide, carbon monoxide, carbon dioxide, inert and controlled atmospheres, natural gas, refinery gases, liquid hydrocarbons, hydrogen, and nitrogen.

GET GIRDLER ON THE JOB AND GET IT DONE RIGHT

CHEMICAL ENGINEERS AND CONSTRUCTORS

The GIRDLER CORPORATION

GAS PROCESSES DIVISION, Louisville 1, Kentucky
District Offices: 150 Broadway, New York 7, N. Y.
2612 Russ Bldg., San Francisco 4, Calif.
311 Tuloma Bldg., Tulsa 3, Okla.

NEW PRODUCTS AND MATERIALS

R. W. PORTER, Assistant Editor

CONTENTS

ADHESIVES

Two NEW adhesives have recently been announced by the E. I. du Pont de Nemours & Co., Wilmington 98, Del. The first of these is an industrial adhesive requiring no catalyst or special preparation and is designated as No. 4665 cement. It is a liquid adhesive which is claimed to be tough and flexible, suitable for bonding metal foils and metal sheets to wood, plastics, vulcanized synthetic and natural rubbers as well as other substances that have widely different coefficients of thermal expansion. It can be applied without thinning, by brushing, roller coating, knife coating, or dipping. It contains 27.5 percent solids. Although insoluble in water, its bond strength is lowered by continued immersion. However, it is claimed that the original bond strength is regained after removal from water The dried adhesive film is claimed to be resistant to dilute alkalis, acids and corrosive salt solutions. It is also not attacked by petroleum or coal-tar solvents, lubricating oils, alcohols, ethylene glycol, or vegetable oils but it is soluble in ketones or ester solvents. It is also said to be resistant to mildew and fungi. It is suggested that this new material will find application for use with metals, woods, plastics, fabrics, ceramics, vulcanized rubber, paper, natural and artificial leather, plaster and walls or wallboards, concrete and glass.

The second of these two products is a synthetic waterproof adhesive claimed to be more resistant to oxidation than similar natural rubber compounds. This new adhesive cement is recommended for bonding buna-N synthetic rubbers and vinyl films or sheet stocks to rigid surfaces such as steel aluminum, glass, wood or concrete. It has been given the brand name of No. 5118 Fairprene adhesive cement and has a thermoplastic synthetic elastic composition which does not require vulcanization to obtain maximum adhesive strength. Oils or gasoline will weaken the bond slightly although aromatic hydrocarbons will destroy the bond. It is unaffected by temperatures as low as 40 deg. F. but is weakened at temperatures of 150 deg. F. and higher. It is claimed, however, that full bond strength returns after cooling to normal temperatures. No. 5118 is cold setting and dries to a tacky surface under average conditions in 3 to 10 minutes, and dries completely within two hours.

INSULATING ROOF COATING

SAID TO have unusual insulating, waterproofing and fire resistive qualities, a new roof coating called Richlume, is now manufactured by the Richkraft Co., Chicago, Ill. This coating was developed for use on bituminous roofing materials only. A new plastic vehicle for the aluminum pigment is claimed to produce a close bond with roofing materials without penetrating below the roof surface. It may be applied with brush or spray to tar and gravel tar paper, built up asphalt or composition shingle roofing. It is claimed that the vehicle remains flexible and allows the coating to expand and contract with the roofing under weather conditions, thus preventing cracking, bleeding or checking of the surface. Insulating qualities result from its reflective surfaces which are claimed to reflect up to 80 percent of the sun's rays.

SOLVENT CLEANING AGENT

AN EMULSIFIABLE solvent cleaner designated as Emulsion Cleaner EC-75 has been developed by Enthone, Inc., 442 Elm St., New Haven, Conn. This product is recommended for the removal of oil, buffing compounds and other organic dirt as well as solid dirt from all types of metals including active metals such as zinc, aluminum, brass and nickel silver. One feature of this product is that it will not affect alkali cleaners. It is used undiluted. The material is a penetrating solvent to replace naphtha, kerosene and chlorinated solvents and in addition is claimed to have high detergency and emulsifiability. It is not affected by oil contamination and requires no heating.

JAPANESE PHARMACEUTICAL

ACCORDING to Japanese clinical records, a new drug called Koha appears to be remarkably effective in speeding the healing of severe burns, lesions, ulcers, frostbite, tubercular leprosy, and other diseases. This material is a derivative of neocyanine and was produced by Japanese pharmocologists in a effort to find an agent resembling chlorophyll which would convert sunlight into energy for therapeutic effect. Unable to obtain active chlorophyll, the researchers experimented successfully with neocyanine, a light sensitive agent. The drug is not effective when used as a local dressing, but must be administered intravenously. It is claimed that the drug increases the number of white corpuscles in the blood stream, stimulates regeneration of tissue and increases the survival rate of damaged tissue cells. This new material is more completely described in a report entitled "Pharmocology and Malariology in Japan"; PB-31614; photostat, $8; microfilm, $3; 120 pages. It is available from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

PLASTIC STABILIZING AGENT

DEVELOPED by the Advance Solvents & Chemical Corp., New York 16, N. Y., a new stabilizing agent, to prevent discoloration and chemical breakdown of vinyl chloride and vinyl chloride acetate copolymers when processed at high temperatures and exposed to sunlight, is now available. Under the brand name of Stabilizer V-1M, this material is said to be compatible and soluble in vinyl resin solutions and can be used in lacquers and coatings based on these materials. Working of vinyl resins at high temperatures without decomposition of the resin may be accomplished by use of this stabilizer to produce clear, transparent films.

ALUMINUM OXIDE ABRASIVE

BY USE of a newly developed process, the Norton Co., Worcester 6, Mass., is now producing a new type of aluminum oxide abrasive. Known as 32 Alundum abrasive, this material is claimed to have a number of advantages over other types of abrasives. It is claimed to cut deeper and faster, cut freer without burning, require fewer dressings, give longer wheel life and reduce grinding time. It is made by a patented process which creates single crystals of high purity in a fluid matrix in an electric furnace. Crystals are separately

formed and have strong solid shapes and many sharply pointed nubs. To retain these many sharp cutting edges the crystals are not crushed but are separated from the matrix by a complicated and continuous chemical process. They are then screened without crushing into the standard grain sizes.

BRITISH SYNTHETIC TEXTILE FIBER

Still in the preliminary stage of development, a new synthetic textile textile-fiber is now under investigation by the Imperial Chemical Industries, Ltd., 42 Hertford St., London, England. This new fiber produced from a polyester derived essentially from terephthalic acid and methylene glycol has been given the name of Terylene.

The most notable property of Terylene so far observed is its markedly high resistance to light and to heat. Another property is its high initial elastic modulus which should permit it to be readily woven or knitted. Terylene is resistant to microorganisms and bacteria and it is chemically resistant to acids, organic solvents and bleaching agents. It has low moisture absorption and does not swell in water and has good resilience with a high ratio of wet to dry strength. Terylene fabrics can be ironed, laundered and steam-pressed normally. The fiber, however, presents problems in dyeing, and research on this subject is being carried out. Fine filaments can be made as well as heavy coarse filaments giving a wide potential range of texture and types of fabrics.

CONCRETE FLOOR PAINT

Made from Gilsonite by the Tiz-Nu Corp., 673 Coronado St., Los Angeles, Calif., a concrete floor paint under the trade name of Rubbermastic, is available in color. This floor paint dries tack free in four hours to an enamel-like finish. It is claimed that use of this product will eliminate the necessity of etching or priming and will do away with saponication troubles. It is also claimed to be completely waterproof and will resist acids, alkalis, heat, electrolysis, weather and abrasion. Rubbermastic paint is available in commercial quantities.

DIMENSIONAL STABILIZED WOOD

A chemical treatment for wood to give it greater dimensional stability was recently announced by the Forest Products Laboratory of the U. S. Department of Agriculture at Madison, Wis. The wood is treated with vapors of a solution of pyridine and acetic anhydride. This swells the wood, reduces by 70 percent its tendency to swell further or shrink, toughens it, improves its resistance to decay and may even improve its strength properties. So far, however, this treated wood has not been evaluated as to the effects of this acetylation process (so-called) on gluability and paintability.

PLASTICIZER FROM PETROLEUM

A petroleum derived plasticizer known as SV Sovaloid C available from Socony Vacuum Oil Co., Paulsboro, N. J., is claimed to possess a number of properties which make it worthwhile for use in plastisols, and as a film for fabrics. When used as a film for fabrics, it is applied by roller or knife coating methods in almost any desired thickness on simple coating equipment. It is a less efficient plasticizer than other types used with vinyl resins but its lower cost overcomes this feature. It may be used as a partial or complete replacement for other plasticizers. In both these applications tensile strengths equal to those obtained from other plasticizers are obtained when using larger quantities of SV Sovaloid C. In high concentrations it gives no evidence of exudation of the plasticizer from the finished product. It has a characteristic odor slightly similar to kerosene.

SYNTHETIC DETERGENT

Development of a synthetic detergent for treating textiles has been announced by the Dexter Chemical Corp., New York, N. Y. Available in two forms under the brand names of Clavodene Concentrate, a 100 percent liquid synthetic detergent, and Clavodene No. 100, an aqueous solution of the concentrate. These products are high molecular weight amine condensation compounds and are recommended for use as detergents in neutral, mild acid, or alkaline solutions. This detergent may be used in the scouring or dyeing of wools or cottons. It is claimed to have good dye-leveling properties and is recommended in both the boiling-off and the dyeing of all types of hosiery. It may be used for wetting out in the rayon processes, as well as cotton. It may also be used in the kier boiling of cotton, and is said to improve the removal of foreign material to enable bleaching with a minimum amount of bleaching agent. Clavodene may be used for rewetting, since it retains its wetting power after drying on the goods.

COPPER MARINE PAINT

A marine paint, claimed to be particularly effective against marine life because it contains metallic copper in combination with other ingredients, has several times the service life of ordinary ship hull paint. Developed by research chemists of the Battelle Memorial Institute, this new paint, which can be used over metal and wood, has been subjected to extensive service tests. It is manufactured under license by Amercoat Division, American Pipe & Construction Co., New York, N. Y.

ELASTIC FABRIC

Developed in the textile laboratories of the United States Rubber Co., Rockefeller Center, N. Y., a new elastic fabric under the brand name of Strex is now available in experimental quantities. The fabric does not contain rubber, and elasticity is achieved by twisting cotton yarn into the shape of a coil spring. The fabric can be made in various degrees of elongation up to a maximum of 100 percent. It has a lower degree of tension than Lastex and similar materials deriving their elasticity from rubber, but is claimed to withstand repeated laundering or dry cleaning. It has been used for such articles as slip covers, gloves, sweaters and surgical bandages.

LATEX

Announcement of a new aqueous film-forming material by the Dow Chemical Co., Midland, Mich., should be of interest to the paint, paper and textile industries. Called Dow Latex 512, it will provide an immediate source of supply to those industries that are facing current short supplies of edible vegetable oils such as linseed. Dow Latex 512 is a combination of styrene and butadiene which when air dried is claimed to form a rubbery and tough film with good pigment binding properties and high protective value. Its compatability with many aqueous emulsions or dispersions of resins, oils, varnishes, starches, waxes, casein, plasticizers and water soluble gums and pigments is another of its important characteristics. The new product is in production and immediately available in 55-gal. non-returnable steel drums and tank cars.

MASKING PLASTIC

Manufactured by the DuBois Co., Cincinnati 3, Ohio, a new masking plastic for paint spray booths is now available. Under the brand name of Filmite, this fluid compound when brushed or sprayed over the walls of dried paint spray booths, forms a tough surface skin over a non-hardening base. This skin resists the impact of paint particles and prevents penetration of the coating and adherence to the wall. Overspray adheres to and accumulates on the skin which, when cleaning is desired, may be peeled from the soft undercoat readily. This compound is supplied in liquid form ready to use. It is water soluble. Filmite is claimed to be non-flammable, non-irritating, non-corrosive and non-toxic.

MOLDING POWDER DYES

Either clear or opaque molding powders are readily colored with a new line of dye materials recently announced by the Krieger Color & Chemical Co., 6531 Santa Monica Boulevard, Hollywood 38, Calif. Designated by the manufacturer as "Poly supra concentrate molding powder dyes," this new material gives clear and transparent color effects and can be used with such materials as cellulose acetate, polystyrene, methylmethacrylate and vinyl molding powders. Light shades are produced by adding as little as ½ oz.. of this dye material to 26 lb. of molding powder. Medium shades are obtained by adding one ounce to 26 lb. of powder. Application of the dye is easy and simple requiring only that the dye be sprinkled into the molding powder and well mixed prior to being used

in the regular manner. These dyes are available in red, royal blue, blue green, orange, amber, purple, black and yellow. All colors are intermixable which makes it possible to obtain various desired shades of color.

PHOTOGRAPHIC PAPER

Having wide latitude and unusual warmtone characteristics, a new Indiatone portrait projection paper has been announced by the Ansco division of General Aniline & Film Corp., Binghamton, N. Y. This new paper is an enlarging paper intended primarily for portrait use, but it can also be used for contact printing. It is claimed that prints on the new Indiatones do not fog, stain or mottle even with wide variations in developing time. Recommended developing time for optimum print quality is 1½ minutes at 68 deg. F. but good quality prints can be obtained with from ½ to 1½ times the normal exposure by varying the development time between 45 sec. and 4 min. It is available in popular sizes and is packed in ½ gross and 500 unit lots.

PARAFFIN HYDROCARBON

Availability in drum or tank car quantities of isoctane of high purity has been announced by the chemical products department of Phillips Petroleum Co., Bartlesville, Okla. Also known as 2,2-4 trimethylpentane, this material is claimed to have a purity of over 99.9 mol percent. It is claimed to be especially useful as a special solvent and as a chemical intermediate.

INSECTICIDE MATERIAL

Now being manufactured on a semiplant scale, hexaethyl tetraphosphate is available in limited quantities. Having the formula $C_{12}H_{30}O_{13}P_4$, this material is claimed to be useful as an insecticide. It is claimed to be particularly valuable in the control of aphids and spider-mites, in dilutions ranging from 1 to 1,000, or from 1 to 4,000. Hexaethyl tetraphosphate is manufactured by Eaton Chemicals, Inc., 3,100 East 26th St., Los Angeles, Calif.

LIQUID DEFROSTER

A liquid windshield defroster called Merix Frost-Off has been announced by Merrick Chemical Co., Wrigley Bldg., Chicago 11, Ill. This liquid is said to soften grease, ice or frozen rain. According to the manufacturer, it is harmless to auto finishes as it does not contain corrosive chemicals. It is applied with a cloth.

GLASS FIBER DIAPHRAGMS

Askania Regulator Co., 1603 South Michigan Ave., Chicago 16, Ill., has developed a substitute for goat's skin for flexible diaphragms that is said to be superior to that material. Previous to the war imported skins of first quality were the only ones suitable. Diaphragms made of glass fiber, which is non-porous, does not sag or stretch, and is resistant to alkalis and acids, were this company's answer to the skin shortage.

CHEMICAL ENGINEERING NEWS

SYMPOSIUM ON COMMERCIAL CHEMICAL DEVELOPMENT

UNDER the joint sponsorship of The Chemical Market Research Association and The Technical Service Association, a symposium on "Organized Commercial Chemical Development" will be held at the Hotel Roosevelt, New York, on December 12. The morning session will open with introductory remarks by Dr. J. M. Boyd, Phillips Petroleum Co. and symposium chairman. Papers will include "The Need for Organized Commercial Chemical Development" by Dr. C. F. Prutton, head of the department of chemistry and chemical engineering at Case School of Applied Science, Cleveland, and "Chemical Market Research" by M. E. Clark, director of market research, Wyandotte Chemicals Corp., Wyandotte, Mich.

S. D. Kirkpatrick, editor of *Chemical Engineering*, will introduce the luncheon speaker, Jan Oostermeyer, president, Shell Chemical Corp., San Francisco, who will speak on "Why Sales Departments Want Organized Commercial Chemical Development."

Dr. John H. Long, manager of sales research, Hercules Powder Co., Wilmington, will open the afternoon session with a paper on "Market and Product Development." He will be followed by W. H. Harding, director of technical service, American Cyanamid Co., Stamford, who will speak on "Application Research and Technical Service" and Dr. Lawrence W. Bass, director of research and development, U. S. Industrial Chemicals, whose topic will be "The Qualifications and Training of Personnel for Organized Commercial Chemical Development."

A social hour will follow the afternoon meeting and the dinner speaker will be Francis J. Curtis, vice president, Monsanto Chemical Co., St. Louis, who will tell "Why Management Wants Organized Commercial Chemical Development." He will be introduced by Walter J. Murphy, editor, *Industrial & Engineering Chemistry*.

KOPPERS PURCHASES KOBUTA STYRENE FACILITIES

NEGOTIATIONS have been completed with the Office of Rubber Reserve whereby the Koppers Co., Inc., will begin private operation of the styrene facilities at the synthetic rubber plant at Kobuta, Pa., built for the government during the war, it was announced last month by Dan M. Rugg, Koppers' vice president and general manager of its Chemical Division.

The styrene plant has been purchased by Koppers from the War Assets Administration. The company also has obtained for a period of 7½ years the use of certain office, laboratory, and shops facilities, steam generating plant, river pumping station, tanks and other equipment which the government was unwilling to sell at the time. The consideration for the deal was about $3,300,000.

Koppers plans to expand its chemical operations at Kobuta and to substantially increase its production of synthetic organic chemicals Mr. Rugg stated. Of the 350 acres included in the complete Kobuta plant, Koppers has purchased 129 acres and obtained the use of 83 additional acres. A condition of the private operation by Koppers of the styrene plant is that a substantial amount of the future production will be reserved for the Office of Rubber Reserve for synthetic rubber. In the first six months, 70 percent of the production will be available to the government and after that 50 percent. Thereby the Office of Rubber Reserve is assured styrene to whatever extent is needed for its synthetic rubber requirements.

BAKELITE TO MAKE VINYLITE PLASTICS IN ILLINOIS

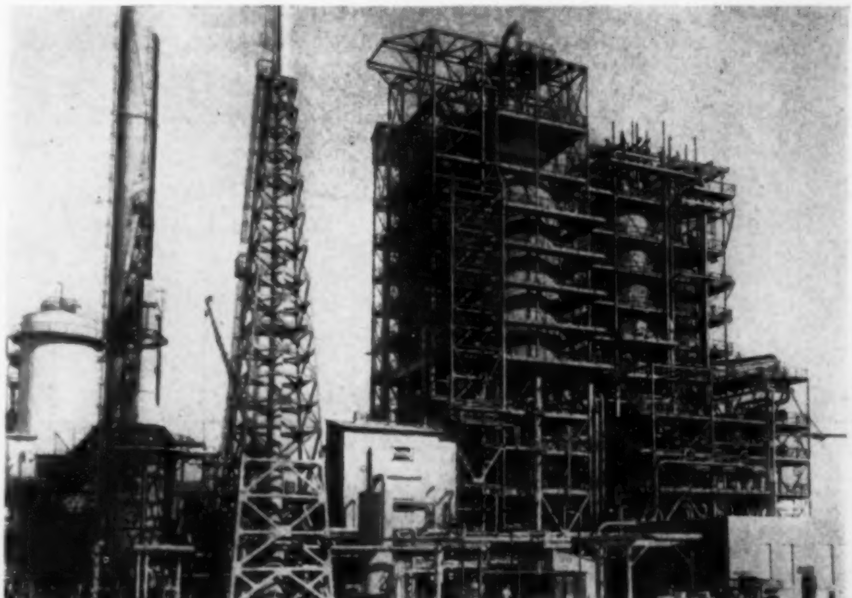
CONSTRUCTION work is now under way on a new plastics plant for the Bakelite Corp. on property recently acquired at Ottawa, Ill. The site of 120 acres was acquired from the Reconstruction Finance Corp. which during the war started to build there a plant to make truck tires. Bakelite plans call for a manufacturing building to include six bays for the production of Vinylite plastic film and sheeting and one complete pressing unit for the production of plastic rigid sheets.

The primary vinyl resins will be produced by Carbide & Carbon Chemicals Corp., another unit of Union Carbide & Carbon Corp., and shipped to the Ottawa plant for further processing. Key personnel for the new project have been chosen from Bakelite's organization at Bound Brook, N. J., and include A. B. Dickinson, superintendent; J. A. Bruton, assistant superintendent; J. E. C. Valentin, works engineer; W. O. Ackerman, in charge of manufacturing office; and J. H. Haynes, head of works laboratory.

SHELL CHEMICAL TO EXPAND CAPACITY AT HOUSTON

A $2,500,000 expansion program which is expected to increase Shell Chemical Corp.'s capacity to produce methyl ethyl ketone and secondary butyl alcohol by 150 percent is now well under way, J. Oostermeyer, president of the company, announced last month. The expansion program is to be directed chiefly toward the installation of facities for the production

New fluid catalytic cracking unit which went on-stream Wednesday, October 9, at the Whiting, Indiana refinery of the Standard Oil Co. (Indiana). With a daily capacity for making 1,050,000 gal. of gasoline, fuel oil and other petroleum products, this is the first of four cat-crackers planned by Standard of Indiana as part of a previously announced $150,000,000 construction and expansion program. Engineering and construction is being done by The M. W. Kellogg Co., petroleum engineers, of Jersey City and New York under the general supervision of the technical staff of Standard Oil Co.



of these chemicals at the corporation's Houston, Tex., plant. Contractor for expansion of the Houston facilities is to be C. F. Braun and Co., Los Angeles. Maximum production is scheduled to be attained by third quarter, 1947.

CONSULTING CHEMISTS HOLD ANNUAL DINNER MEETING

The annual dinner meeting of the Association of Consulting Chemists and Chemical Engineers, Inc., was held at the Hotel Sheraton, New York, on the evening of October 22. Following the dinner a symposium was held on the subject of "Licensing of Chemical Engineers and Chemists" with Albert Parsons Sachs, John M. Weiss and Louis Weisberg as speakers. Numerous speakers participated in the discussion from the floor. At the meeting, the newly elected officers and directors were announced. Officers for the coming year

CONVENTION CALENDAR

American Institute of Chemical Engineers, annual meeting, Atlantic City, December 1-4.

Seventeenth National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, N. Y., December 2-7.

American Pharmaceutical Mfrs. Association, midyear meeting, Waldorf-Astoria Hotel, New York, N. Y., December 9-11.

Chemical Market Research Association and Technical Service Association, joint symposium, Hotel Roosevelt, New York, N. Y., December 12.

American Association of Textile Chemists and Colorists, annual meeting, Statler Hotel, Boston, Mass., December 12-15.

Synthetic Organic Chemical Mfrs. Association, midyear meeting, Hotel Roosevelt, New York, N. Y., December 17.

Society of Plastics Engineers, convention, Congress Hotel, and plastics exposition, Navy Pier, Chicago, Ill., January 28-February 2.

Seventh International Heating and Ventilating Exposition, Lakeside Hall, Cleveland, Ohio, January 27-31, 1947.

American Society For Testing Materials, spring meeting, Benjamin Franklin Hotel, Philadelphia, Pa., February 24-28.

American Society of Metals, western metal congress and exposition, Civic Auditorium, Oakland, Calif., March 22-27.

National Association of Corrosion Engineers, annual meeting, Palmer House, Chicago, Ill., April 7-10.

American Chemical Society, 111th national meeting, Atlantic City, N. J., April 14-18.

Second National Plastics Exposition, Coliseum, Chicago, Ill., May 5-11.

are Nicholas M. Molnar, Molnar Laboratories, New York, president; Prof. A. Taub, College of Pharmacy, New York, vice president; M. F. Lauro, Bureau of Chemistry, New York Produce Exchange, secretary; and P. F. Wehmer, Electrical Testing Laboratories, New York, treasurer. New directors are C. A. Blair, The Blair Laboratory, New York; Gustavus J. Esselen, Gustavus J. Esselen, Inc., Boston; and Earl D. Stewart, Schwartz Laboratories, New York. Albert Parsons Sachs, past president and consulting engineer of New York is a hold-over director.

GAS ASSOCIATION MEETS WITH LARGE "SHOW"

American Gas Association held its first full-scale convention at Atlantic City from October 7 to 11 with the support of a large appliance exposition held under the auspices of Gas Appliance Manufacturers Association. Both the convention and the exposition had near record support in attendance and interest.

AGA will be led during the coming year by newly selected officers: president, R. H. Hargrove, United Gas Pipe Line Co., Shreveport, La., and vice presidents, Hudson W. Reed, The Philadelphia Gas Works Co., and Robert W. Hendee, Colorado Interstate Gas Co., Colorado Springs, Colo. The technical section officers for the coming year are: chairman, C. S. Goldsmith, The Brooklyn Union Gas Co., and vice chairman, A. C. Cherry, Cincinnati Gas & Electric Co.

The next convention of AGA will be held in San Francisco during October of 1947. Meantime various sections and regional groups will hold their customary "Conferences." Most important of these special meetings will be the Production and Chemical Conference, tentatively scheduled to be held in New York during May.

POWER SHOW WILL FEATURE ENGINEERING ADVANCES

Technical advances, widely influencing the entire outlook for the production and use of industrial power, will be featured at the 17th National Exposition of Power and Mechanical Engineering. Returning once more to its traditional site in Grand Central Palace, New York, December 2-7, the exposition will be held coincident with the annual meeting of the American Society of Mechanical Engineers.

Progress in methods, practice and equipment design, as revealed by the exhibits promise a considerably greater advance all along the line than has often been noted at these biennial displays because of the dual influence of innovations in war production and also the partial suspense of commercial animation during the past decade. Many products at the Power Show will be entirely new, others revised to incorporate an improved selection of materials; new methods of manufacture have also encouraged design changes from the motive of economy in a good many instances.

The exposition, as in past years, is primarily a forum for the manufacturers and users of power plant equipment—fuel

handling, combustion, the distribution, economizing and utilization of heat, auxiliaries, measuring and recording instruments, controls and even applications of power in a number of classes of machinery, especially that intended for the construction, upkeep and overhauling of power plants.

With approximately 400 exhibits, filling all available space on four floors of the Palace, the exposition will be one of the largest and most diversified ever held. Much of novelty and technical interest is being held back by exhibitors for disclosure after the opening date. A review of information on the displays made available by exhibitors in advance, however, indicates a well rounded program of new information.

NEW SULPHURIC ACID PLANT BUILT AT CHARLESTON

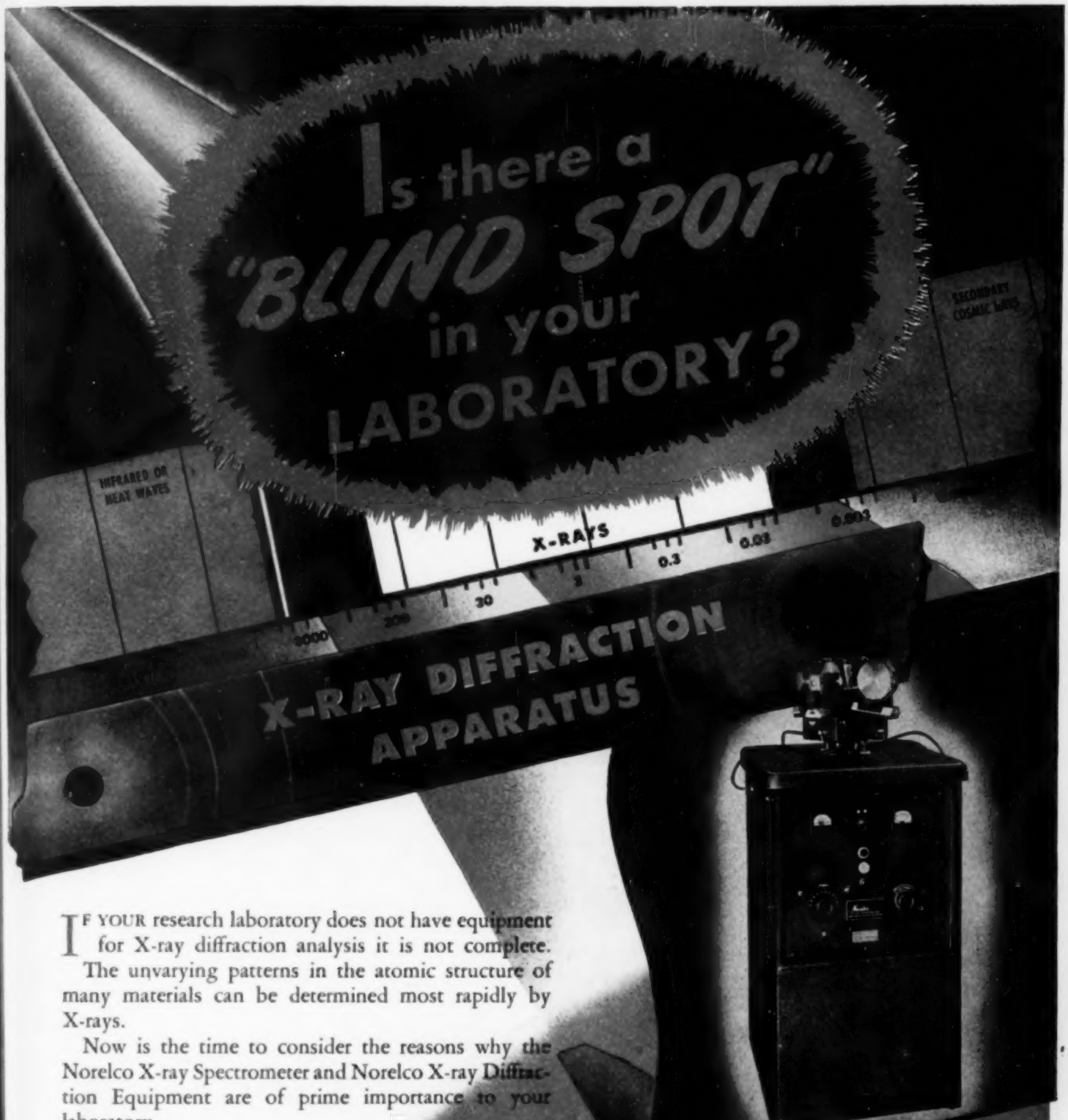
A new sulphuric acid plant has been under construction at Charleston, S. C., according to an announcement by officials of the H. K. Ferguson Co. The plant was erected for A. F. Pringle & Co., Inc. and is to replace a box chamber acid plant destroyed by fire early last February. The new plant consists of six Mills-Packard chambers.

GERMAN PLANTS APPROVED FOR INDUSTRIAL REPARATIONS

Reports from the Allied Control Council at Berlin indicate that some progress is being made in forwarding the Potsdam program for industrial reparations from Germany. Up to September 15 about 500 German plants in the three western occupation zones had been officially listed as available for reparations. However, neither regulations nor official policy have been developed to govern eventual transfer of German reparations, acquired by the United States, to private concerns except a decision giving jurisdiction over this prospective job to the office of Foreign Liquidation in the State Department.

Originally the United States was awarded 28 percent of the plants and facilities taken from Germany as reparations but it voluntarily pared down its share to 11.8 percent in order that more of these plants and facilities might be made available to the smaller European nations. So far only one American claim has been officially filed. This is for the Hensoldt & Sons optical instruments factory at Herborn, in Hesse-Nassau. The plant has 240 undamaged machine tools which a pool of 11 American optical and engineering firms would like to have for domestic use. An American claim probably will be filed for that part of the Aschau armaments plant at Muelhdorf, Bavaria, which makes briquettes. An American firm wants to acquire this plant for operation in Salonika, Greece, where the company is under contract to install a hydroelectric project.

For a time, plants were allocated and removal from the western zones actually started, on the theory that such removals, before a final settlement was reached, could not exceed the amount any nation would be allotted in the peace terms and also on the theory that the plants should be put into operation outside Germany as soon as



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possible. Owing to political developments this procedure was halted and a freeze order now is effective in the western zones.

German Plants for Reparations
Approved up to September 15, 1946

Plant	Location
Optical Instruments	
Hensoldt & Soehne	Herborn
Explosives and Propellants	
Fabrik Hess Lichtenau	Furstenhagen
Fabrik Kaufbeuren	Kaufbeuren
Fabrik Aschau	Muhldorf
Fabrik Ebenhausen	Ingolstadt
Warren Commission AG	Dannenberg/Elbe
Dynamit AG	Duneberg
Dynamit AG	Krummel
Clausthal	Clausthal, Sellerfeld
Fabrik Allendorf	Allendorf, Greater Hesse
Fabrik Bobingen	Bobingen, Bavaria
Fabrik Kaufering	Kaufering, Bavaria
Pulverfabrik Hasloch	Hasloch, Bavaria
Werk Kraiburg	Kraiburg, Bavaria
Wolf & Co. Factory A	Bomlitz
Wolf & Co. Factory B	Duerverden
Wolf & Co. Factory C	Liebenau
Soda Plant	
Mathes & Weber	Duisburg
Activated Carbon	
Chemische Werke	Harzweser, Langelsheim
Vinyl Chloride	
I. G. Farbenindustrie AG	Rheinfelden
Acetone	
Degussa	Mainz, Mombach
Solvents and Pharmaceuticals	
Anorgana GmbH (except ethylene-glycol unit)	Gendorf, Bavaria
Oxygen and Industrial Gases	
Kasselwerke	Kassel-Bettenhausen
Suarstoffwerke	Griesheim
Organic Chemicals and Dyes	
C. F. Hahneberg GmbH	Lesse, Hannover
Lonalwerk GmbH	Lesse, Hannover
I. G. Farbenindustrie	Ludwigshafen
Griesheim Werke	Griesheim, Greater Hesse
Offenbach Werke	Offenbach
Pentaerythritol	
Werke Schrobenhausen	Schrobenhausen, Bavaria
Werke Lippoldsberg	Lippoldsberg, Bavaria
Werke Welden	Welden, Bavaria
Synthetic Rubber	
Chemische Werke Huels part only	Muenster
I. G. Leverkusen (part only)	Leverkusen/Koeln
Pyrotechnics	
Hans Moog	Wuppertal, Ronsdorf
Burmester Trittau	Hamburg
Fabrik Fritz Sauer	Gersthofen, Bavaria
Carl Fleming	Neugraben/Hamburg
Carl Fleming	Neugraben/Hannover
Synthetic Gasoline	
Chemische Werke Essener Steinkohle AG	Bergkamen
Dortmunder Paraffin Werke	Dortmund
Gelsenberg Benzin AG	Gelsenkirchen
Gewerkschaft Victor Castrop-Rauxel Hydrierwerk Scholven AG	Gelsenkirchen-Buer
Krupp Treibstoffwerk	Wanne-Eickel
Ruhrchemie AG	Oberhausen-Holten
Ruhroel GmbH	Bottrop-Bay
Steinkohlenbergwerk Rheinpreussen Chemische Werke	Meerbeck-Moers
Union Rheinische Braunkohlen Kraftstoff AG	Wesseling

GENERAL MILLS TO EXPAND IN CHEMICAL FIELD

THAT General Mills is contemplating a larger participation in the manufacture of chemicals is indicated by an announcement that the Chemical Division of the company is planning the construction of a plant at Kankakee, Ill., which will be used for the production of organic chemicals. The Division now operates a polyamide resin plant in Minneapolis. The Chemical Division also is in charge of the

PUMPING STATION IN THE WELL

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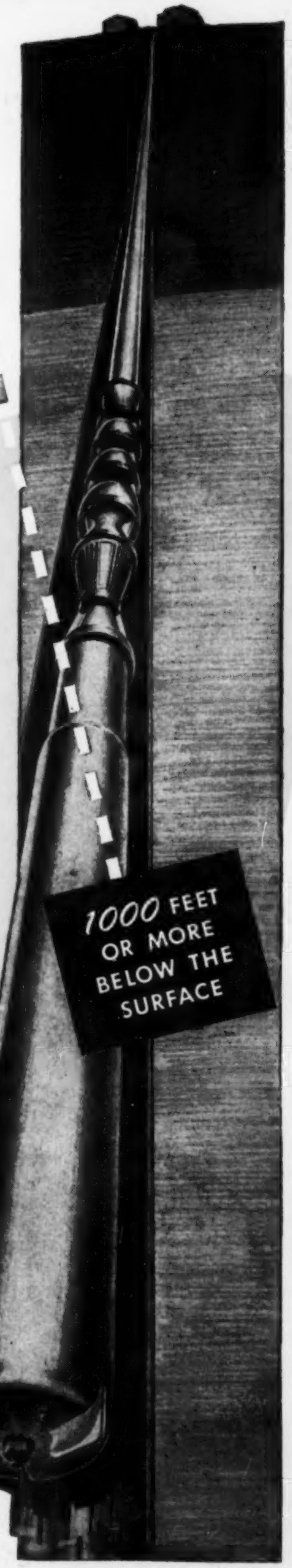

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- NO WELL TOO DEEP
- ADAPTABLE TO CROOKED WELLS
- MAXIMUM EFFICIENCY
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- NO WATER CONTAMINATION
- SILENT OPERATION
- UNAFFECTED BY FLOODS OR ATMOSPHERIC CONDITIONS
- SAFE AGAINST VANDALISM

soybean oil refining unit which went into operation last September at Belmond, Iowa. At this refinery, lecithin is removed from crude soybean oil by a degumming process. Three other oil refining units are about ready to be placed in operation.

FIRST NATIONAL MATERIALS HANDLING EXPOSITION

The first exposition to deal entirely with material handling problems of industry will be held at the Public Auditorium, Cleveland, January 14-17. The problems of the chemical field will receive special attention in a separate program of prepared papers and panel discussions. Chemical executives will have an oportunity to see and compare under one roof competing systems and machinery for materials handling. Production line handling as well as handling for receiving, stacking, shipping, loading, and warehousing will be considered by the panels.

Earl I. Burke, manager of shipping, Republic Steel Co., heads the policy committee of the exposition which is under the management of Clapp & Poliak, Inc. of New York.

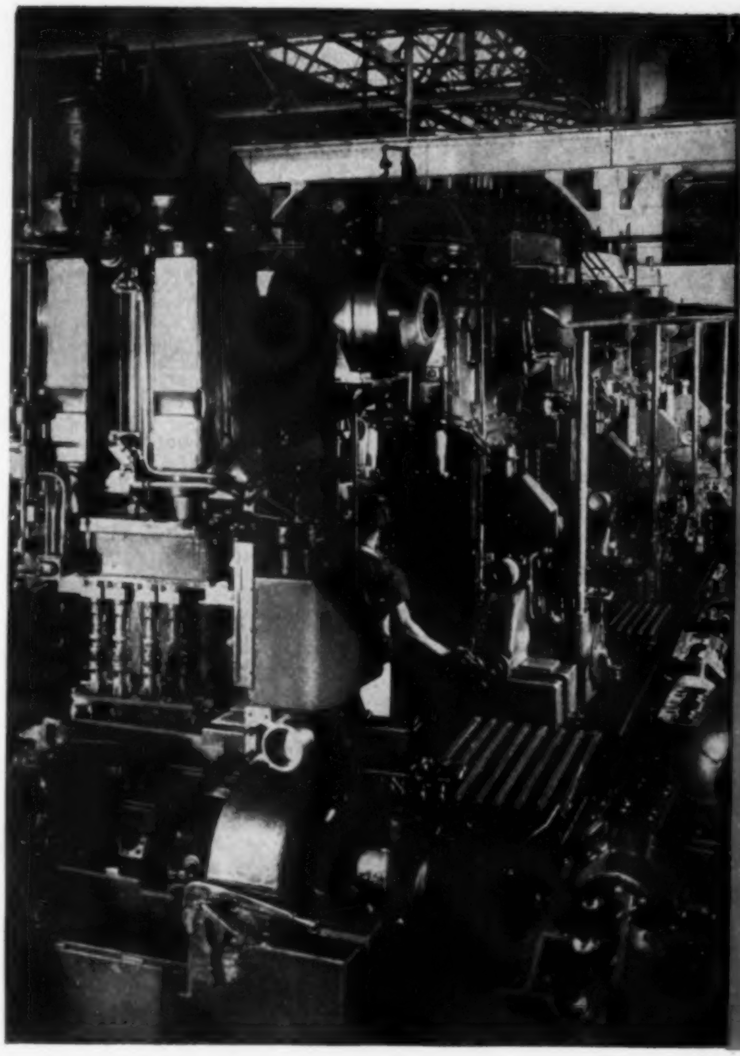
DUPONT ANNOUNCES PLANS FOR PLANT EXPANSIONS

Plans for construction of a new unit on its electrochemicals plant site at Niagara Falls have been announced by E. I. du Pont de Nemours & Co. The new unit will be used for the manufacture of adiponitrile which will be shipped to other plants for further processing. It will consist of four main buildings including a general office, and laboratory building, a power plant, water-pumping station, electric substations, and miscellaneous structures. R. L. Hardy, manager of the Niagara Falls plant says the project is estimated to cost about $1,000,000 and construction would require about 15 months.

The company also reports that the Civilian Production Administration has approved approximately $600,000 of new construction which will be used to enlarge its facilities for producing synthetic detergents at Deepwater, N. J.

GENERAL ANILINE & FILM RECORD OF RESEARCH

More than 300 inventions and improvements in the chemical, dyestuffs, plastics, and photographic fields have resulted from the work of the Central Research Laboratory of General Aniline & Film Corp. since its establishment at Easton, Pa., in 1942, George W. Burpee, president, disclosed last month in announcing the appointment of Dr. Arthur L. Fox as director of the laboratory. Mr. Burpee said that company research had made it possible to duplicate virtually every dyestuff formerly imported from Germany. He classed as outstanding among the company's research accomplishments, the development of a new line of chemicals from acetylene. The company is now constructing at Grasselli, N. J., a semi-works and pilot plant where chemicals from acetylene will be made by



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techniques developed by the company. Dyestuffs and various textile auxiliaries also will be produced there.

R. LINDLEY MURRAY TALKS ON ALKALI AND CHLORINE

Members of the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers heard a talk by R. Lindley Murray, of Niagara Falls, N. Y., vice-president in charge of research and development of the Hooker Electrochemical Co., at their meeting on October 10 in the Hotel DuPont, Wilmington, Del.

Mr. Murray spoke on "The Growth of the Electrolytic Alkali and Chlorine Industry." Raymond P. Genereaux, chairman of the section, announced the appointment of the following nominating committee which will present its report at the next meeting to be held in Philadelphia December 10: David Shaw, H. S. Lukens, R. M. Lawrence and James Lawrence.

ENGINEERING FOUNDATION ELECTS OFFICERS

Holding its annual meeting on October 17 in the Engineering Societies Bldg., New York, the board of directors of The Engineering Foundation re-elected Dr. A. B. Kinzel as chairman for the coming year. Dr. Kinzel is vice president of Union Carbide & Carbon Research Laboratories, Inc., and of the Electro Metallurgical Co. Other officers elected were Dr. L. W. Chubb, director of the Westinghouse Research Laboratories, vice chairman; Dr. Edwin H. Colpitts, formerly vice president of Bell Telephone Laboratories, re-elected director; and John H. R. Arms, re-elected secretary. Dr. Kinzel will represent the Foundation on the executive board of the National Research Council.

PACKAGING FORUM WILL BE HELD IN CHICAGO

Individual packaging conferences by industry groups rather than general discussions of suppliers, manufacturers, and machinery makers, will feature the eighth annual two-day Forum of the Packaging Institute which will be held at the Hotel Stevens, Chicago, on November 25-26. Walton Lynch is president of the Institute and Mason Rogers, Dewey and Almy Chemical Co., is chairman of the program committee.

WOOD DISTILLATION WILL BE DISCUSSED IN BOSTON

The Northeastern Wood Utilization Council will discuss wood distillation during its next invitation meeting to be held in the Parker House, Boston, Mass., on December 12.

The last 25 years have marked the steady decline of the hardwood distillation industry due to inroads caused by synthetic methanol and acetic acid. Yet charcoal cannot be duplicated by any synthetic process and is a vital product by itself or as activated charcoal. Work will be reported on both an improved design of a charcoal kiln to make that

product alone and the latest techniques of wood distillation. The continuous processes giving rise to 60 percent higher yields of charcoal, acetic acid, and wood alcohol, will be reported and evaluated.

AMERICAN ENKA TO BUILD RAYON TIRE YARN PLANT

The American Enka Corp., manufacturers of rayon yarns, has awarded contracts for engineering and construction of a new rayon tire yarn plant, to be located at Lowland, Tenn., to The H. K. Ferguson Co. The plant will consist of a complete new production unit, and the contract covering its design and construction is one of the largest industrial building contracts awarded in recent months.

Approval for the project has been granted by the Civilian Production Administration and construction at the plant site is expected to start immediately. Design work is now in progress in the Cleveland offices of The Ferguson company.

LILIENTHAL HEADS ATOMIC ENERGY COMMISSION

To the Atomic Energy Commission, appointed by President Truman in the latter part of October, goes the responsibility of converting the atom industry from its status of a weapon of war to that of peacetime application. The Commission succeeds Manhattan District as operator of the vast atomic plants at Oak Ridge, Hanford, and Los Alamos, as well as the research institutions such as Argonne Laboratory at Chicago. It will expand Manhattan District's vast peacetime programs. It has a monopoly of production of U-235 and plutonium and will license all industrial and academic work in the field. It assumes jurisdiction over dissemination of all information relating to basic knowledge and discoveries in nuclear physics. These powers are conferred under the terms of the Atomic Energy Act of 1946.

David E. Lilienthal, head of Tennessee Valley Authority, is chairman of the Commission. Named to serve with him are Robert F. Bacher, professor of physics and director of the Laboratory of Nuclear Studies, Cornell University; William W. Waymack, vice president and editor, *Des Moines Register and Tribune*; Lewis L. Strauss, partner, Kuhn, Loeb & Co.; and Sumner T. Pike, former member of the Securities and Exchange Commission.

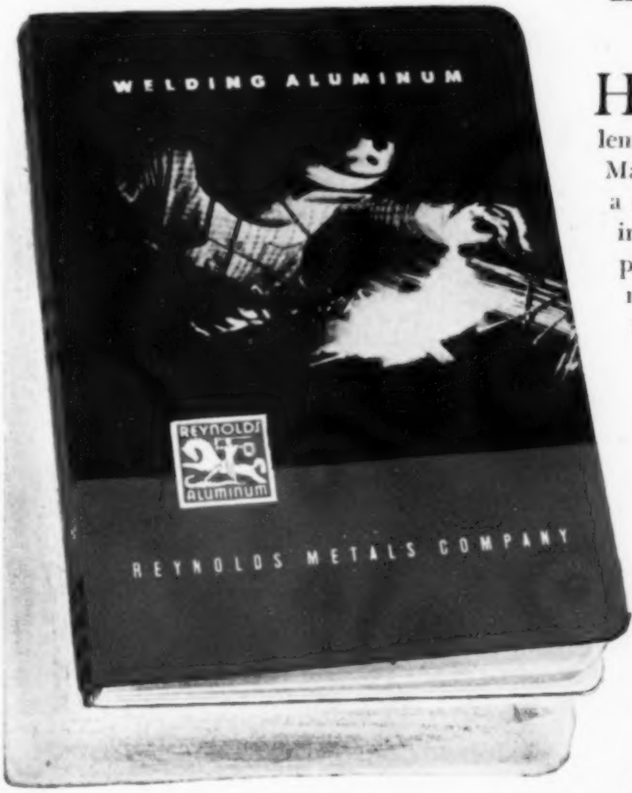
HOOKER ENDOWMENT FUND TO UNIVERSITY OF ROCHESTER

An announcement from Alan Valentine, president of the University of Rochester says that a $50,000 endowment fund for the Department of Chemistry has been established by Harry M. Hooker. The fund will be paid to the university in increments of $5,000 a year for 10 years and is to be used for general purposes of the department of chemistry under the direction of Dr. W. Albert Noyes, Jr., chairman of the department and director of the research laboratory. Dr. Noyes is president-elect of the American Chemical Society.

Mr. Hooker was graduated from the

New! A Handbook on Welding Aluminum

Are you welding aluminum now? Do you plan to weld aluminum in the future? If so, <u>this</u> <u>book</u> <u>is</u> <u>for</u> <u>you</u>!



HERE'S a new up-to-the-minute book, "Welding Aluminum," that presents a concise, authoritative discussion of problems dealing with welding aluminum and aluminum alloys. Many new war-developed applications are described. Under a single cover, in handy usable form, you will find detailed information on 11 aluminum welding processes, from edge preparation to finishing, a comprehensive discussion of aluminum alloys and tempers, and helpful tables on properties, gauges, sizes, and strengths.

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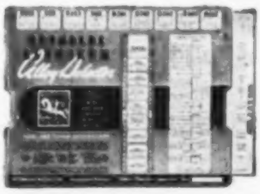

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University of Rochester in 1894. He was elected vice president and sales manager of the Hooker Electrochemical Co. in 1922 and later became president. At present he is chairman of the board of the company.

WAA MOVES NEW YORK UNIT

NOTICE has been issued by the Office of Information calling attention to the fact that the New York unit of War Assets Administration sales information division and display room has been moved from 70 Pine St. to the ground floor of 37 Broadway.

READERS' VIEWS and COMMENTS

CORRECTION AND COMMENT

To the Editor of Chemical Engineering:

Sir:—With reference to the article "Gauss's Formula" by A. E. Kroll, p. 102, September 1946, I suppose a number of letters have been received pointing out the errors in Table I, page 103.*

U_1 for n = 6 should be 0.0338

K_3 and K_4 for n = 4 are reversed

The use of this method of numerical integration will save considerable time over graphical methods in certain cases. Like so many articles of this type, the advantages of the method are expounded, but the equally important restrictions of its use are not clarified. Where the data fit a curve of the nature shown in Fig. 1, the method is good, but where you have several peaks and lows, the method is not applicable with accuracy. This point was not brought out.

FREDERICK BELLINGER

Associate Professor
Department of Chemical Engineering
Georgia School of Technology
Atlanta, Ga.

* Yes, several.—*Editor.*

REBUTTAL

To the Editor of Chemical Engineering:

Sir:—I would like to thank Prof. Bellinger for calling attention to the errors in Table I of the article on Gauss's formula.

Fortunately the functions encountered in most engineering work are relatively simple. In the calculations suggested in the article, curves having several peaks and lows (maxima and minima) very seldom occur. The article was written with this in mind and four points will, in most cases, give desirable accuracy.

Where a function varies rapidly, or in a peculiar manner, or has several maxima and minima, the use of an adequate number of points will give results with accuracy suitable for most practical purposes.

I believe that Gauss's method of integration will save considerable time over graphical methods in most cases, while in certain other cases, where many points are necessary to give the desired accuracy, the graphical method may have the advantage.

A. EDGAR KROLL

Bethlehem, Pa.

Timken 5% Nickel Alloy Tubes

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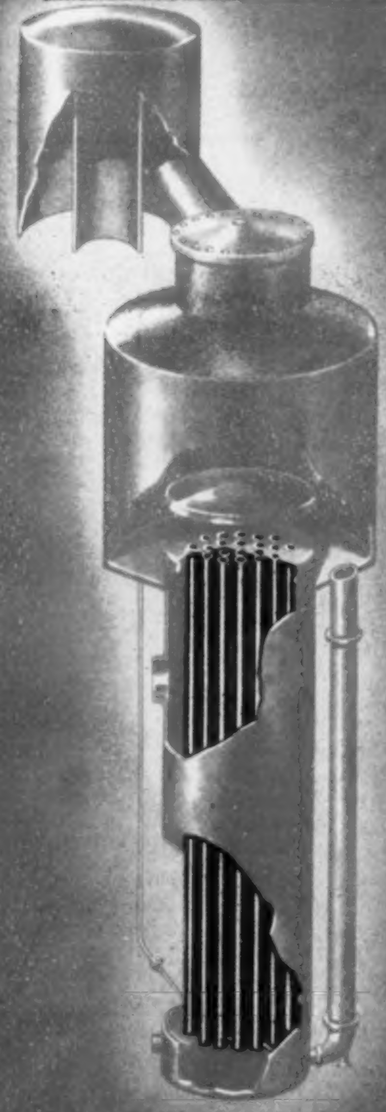

From laboratory studies, and investigations and testing under actual plant conditions, in many northern and southern mills during the last 8 years, Timken has developed 5% Nickel tubes which meet specific black liquor corrosive problems for greatly improved life-over-cost.

No other steel producer has devoted so much research to physical requirements necessary to expedite installation and assure maximum service. Studies have included causes of general corrosive attack and pitting in actual service where black liquor concentrations run over 40% solids, where liquor temperatures exceed 220 degrees F., where sulphidity of cooking liquors exceeds 25%, and where forced circulation evaporators have had thru-put increased by larger pump installations.

Timken 5% Nickel alloy tubes have uniformity of structure and are given flaring and hydrostatic tests at 1,000 lbs. per square inch.

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PACIFIC PROCESS INDUSTRIES

TRENDS • EVENTS • DEVELOPMENTS

JOHN R. CALLAHAM, Pacific Coast Editor, San Francisco, Calif.

COSGRAVE BECOMES WESTERN EDITORIAL ASSISTANT

To ASSIST in the expanding editorial activities of *Chemical Engineering* in the West, Mr. James F. Cosgrave recently joined the publication's San Francisco staff. Mr. Cosgrave will assist the Pacific Coast editor in covering the expanding chemical, chemical process and chemical equipment industries of the 11 Western States and in the launching of this magazine's *Pacific Process Industries* western supplement in January. This section, initiated in July 1945, will thus be able to expand in line with the progress and activities of the chemical process industries of the region.

A native Californian with a family history rich in Mother Lode traditions, Mr. Cosgrave attended Fresno State College and became active in science clubs and school journalism as well as serving as an instructor in chemistry laboratory classes. After obtaining his degree in 1945, Mr. Cosgrave immediately joined the engineering staff of Shell Development Co. in Los Angeles where he was engaged in research and pilot plant development work until he joined *Chemical Engineering* in October.

James F. Cosgrave

WOOD-TREATING LABORATORY OPENED IN OREGON

A LABORATORY to place chemical research in close contact with treatment of Douglas fir and other western species was opened November 1 at the Wauna, Ore., treating plant of American Lumber & Treating Co., according to F. W. Gottschalk, technical director in Chicago. The new research unit will be in charge of William A. McFarland, chemical research engineer, who has been with the firm since 1941.

Besides the plant operation itself, facilities at the Wauna laboratory will include a pilot plant to handle pressure treatment of full-length lumber items, resin impregnation equipment, and facilities for gluing pressure-treated wood into large structural members. Plans include enlargement of facilities, for strength testing and for evaluating electrical restivity of wood.

UTAH SILICA BRICK PLANT SOLD BY WAA

SALE of a silica brick plant at Lehi, Utah, to General Refactories Co. for $375,000 has recently been announced by WAA, who stated that the price was 124 percent of the fair value. High bidder on the plant, which was operated during the war by Gladding-McBean & Co., the firm plans to continue manufacturing silica brick to be used in the lining of steel furnaces and similar purposes. The plant is located on 14.7 acres, has six kilns, and a rated capacity of 4,000,000 silica bricks yearly. According to WAA, the plant is not adaptable to the manufacture of standard brick.

WYANDOTTE EXPANDS WESTERN SODA PLANT OPERATIONS

AN EXPANSION program in western operations by Wyandotte Chemicals Corp. is now under way, according to Charles O. Chestnut, manager of the firm's Pacific Division, San Francisco. The program involves three moves: A long-term expansion in soda ash capacity at the Keeler, Calif., plant of Natural Soda Products Co., a subsidiary since about 1934; production of sodium sesquicarbonate, a new product, at the same plant and expansion of facilities for producing this chemical; and future erection of a new West Coast plant, probably to be located in the Los Angeles area, for compounding detergent and related products.

Using brines from Owens Lake in Inyo County, the Keeler plant of Natural Soda Products Co. has been expanding its output of soda ash from trona for the past three years, and an additional general expansion is now being considered. Output of soda ash for 1946 is expected to be about 50 percent greater than for 1945, according to Mr. Chestnut.

An intermediate in the Keeler operations is sodium sesquicarbonate, which the firm has recently purified, dried and placed on the market as a new product under the name Sesqui-Sec. First commercial production from these new facilities, for which a further expansion is already planned, was during October. In the form of granular crystals and analyzing 40 percent Na_2O, this product goes primarily into detergent compositions; the market is entirely in the West. Compounding operations, new to Wyandotte on the West Coast, will begin at Keeler within a few months; within a year or so the firm expects to erect a large compounding plant in the Los Angeles area. This unit would specialize in laundry, food, beverage and general detergent products and would become a substantial user of western materials such as soda ash, caustic soda, bentonite and volcanic ash.

SPECIALTY PAPER MILL EXPANSION COMPLETED

EXPANSION program of the Westminster Paper Co. at New Westminster, B. C., has been completed and the plant is ready for operations that will double its previous output of 9,000 tons annually of paper towels, tissue, fruit wrapings and waxed papers. Cost of the expansion has been placed at $1,500,000. Increased produc-

Pacific Chemical Exposition Scheduled for 1947

Reflecting the rapid growth in the chemical, equipment and process industries of the West, the first regularly scheduled Pacific Chemical Exposition for the western states and the Pacific area will be presented in the Civic Auditorium, San Francisco, Oct. 21-25, 1947. The Exposition, sponsored by the California Section of the American Chemical Society, will feature an Industrial Chemical Conference and Display and will be under the chairmanship of Paul H. Williams of Shell Development Co. Manager will be Marcus W. Hinson, who has handled the National Chemical Exposition in Chicago since 1940.

Advisory board for the Exposition consists of H. K. Benson, head, Department of Chemistry & Chemical Engineering, University of Washington; Willard H. Dow, president, Dow Chemical Co.; Gustav Egloff, director of research, Universal Oil Products Co.; R. G. Follis, president, Standard Oil Co. of California; A. H. Hooker, western sales manager, Hooker Electrochemical Co.; Louis B. Howard, chief, Bureau of Agricultural & Industrial Chemistry, U. S. Dept. of Agriculture; Sidney D. Kirkpatrick, editor, Chemical Engineering; *Ernest O. Lawrence, director, Radiation Laboratory, University of California; Paul D. V. Manning, vice president, International Minerals & Chemical Corp.; Walter J. Murphy, editor,* Industrial & Engineering Chemistry; *W. Alfred Noyes, Jr., president-elect, American Chemical Society; J. Oostermeyer, president, Shell Chemical Corp.*

Also on the advisory board will be Linus Pauling, director, Gates & Crellin Laboratories of Chemistry, California Institute of Technology; Ralph Sanborn, director of plant coordination, California Packing Corp.; Walter A. Schmidt, president, Western Precipitation Corp.; Robert G. Sproul, president, University of California; Robert L. Taylor, editor, Chemical Industries; *Donald B. Tresidder, president, Stanford University; James G. Vail, vice president, Philadelphia Quartz Co.; Brayton Wilbur, president, San Francisco Chamber of Commerce.*

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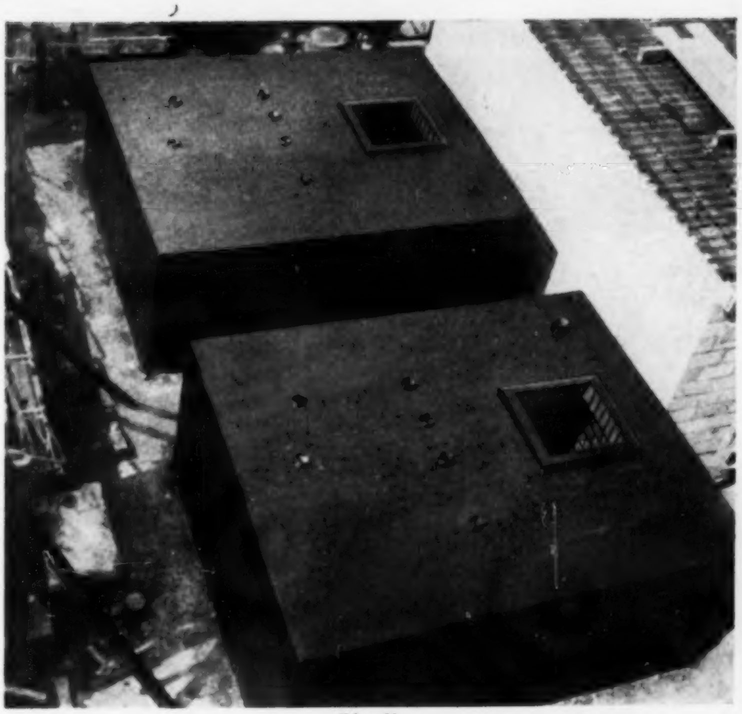
FLOORS of Atlas brick and acid- and alkali-proof cements. . . .

Here are four interesting Atlas installations. Pictures 1, 2 and 3 were taken in one chemical plant; No. 4 in another.



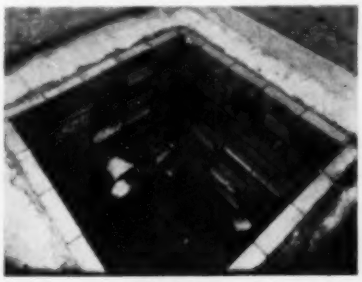
(No. 1)

Two 3000 gallon concrete tanks for storing hydrochloric acid contaminated with organic acids and solvents. These tanks are of Atlas Dual Construction, Carbo-KOREZ (1) and Tegul-VITROBOND (2) and are lined with Atlastiseal (3). Exteriors are protected with Atlastic #31 (4). Tank tops are of reinforced concrete faced on inside with liner plates joined with Carbo-KOREZ (1). Small openings in tops fitted with Saran piping.*

*Fully protected by U. S. Patents.

(No. 2)

Acid- and Alkali-proof floor being laid in process building. Construction is of acid-proof brick joined with Atlas ALKOR (5). This floor is tight, strong and leak-proof.



(No. 3)

Brick and ALKOR (5) lined pit for collecting acid and alkali wastes. Six of these pits are connected in series. Wastes from floor (picture #2) and from chemical process equipment feeds into these sumps. As wastes travel from pit to pit, sludge and solids settle out and wastes finally pass off into sewers.

(No. 4)

Pipe trench laid with white acid-proof brick joined with ALKOR (5). This trench protects building foundation from possible damage due to leaking valves or pipe joints. Trench serves also as supplementary drain when floors are washed down.

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3—Atlastiseal Triple Membrane consists of alternate layers of Atlastic #31 asphaltic cement and Tegul-VITROBOND #440, yellow plasticized sulphur cement.

4—Atlastic #31, asphalt cement, is used as the impervious layer in acid-proof brick floors and for lining concrete sump pits when acid service is not severe enough to call for more expensive Atlastiseal.

5—ALKOR is the **original** acid- and alkali-proof cement, developed by Atlas more than seven years ago. **(ALL OTHERS ARE IMITATIONS.)** ALKOR withstands temperatures to 360° F.

Carbo-KOREZ, Tegul-VITROBOND and ALKOR are inert, each to a given group of acids, alkalis, corrosives and organic compounds.

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tion centers largely around a new Beloit machine capable of turning out 34 tons daily of facial tissues, waxing stock and cellulose wadding. Beater room and finishing room production has also been increased. Unbleached sulphite and groundwood pulp supplies come from Powell River Co., while bleached sulphite is supplied by British Columbia Pulp & Paper Co.

LARGE REFINERY TO BE BUILT IN MONTANA

Plans for construction of a new $8,000,000 refinery at Billings, Mont., by Carter Oil Co. were announced recently by O. C. Schorp, president of the western operating subsidiary of Standard Oil of N. J. The new plant will have a capacity of 18,000 bbl. per day of crude throughput and will include a catalytic cracking unit. Since some delay in delivery of equipment is anticipated, the plant probably will not be able to operate before 1948. It will be the largest of its type in the state of Montana as well as in the entire Rocky Mountain territory.

Carter Oil Co. now operates four refineries, with daily crude capacities as follows: Billings, Mont., 10,000 bbl.; Cut Bank, Mont., 4,000 bbl.; Lowell, Wyo., 3,000 bbl.; Newcastle, Wyo., 1,600 bbl.

STARCH-GLUCOSE PLANT GOING UP IN CALIFORNIA

Ground was broken in late August for a $200,000 starch and glucose plant to be built by the Northwest Chemurgy Corp. of Wenatchee, Wash., (*Chem. & Met.*, June 1946, p. 175) near Hatfield, Modoc County, Calif. The new plant will use cull potatoes for making glucose and starch; daily capacity will be 30,000 lb. of products from 200 tons of potatoes processed during a 3-shift day. The unit, to employ 60 persons, is expected to operate ten months of each year. The making of glucose and starch from potatoes is a comparatively new process in the United States, being introduced in the State of Washington about six years ago. In addition to using culls, the plant can absorb number 2 grade potatoes when marketing elsewhere is unprofitable. Clarence Rice is superintendent. The Klamath Potato Products Co. of Caldwell, Idaho, also has a plant under construction at Merrill, Ore. Both plants expect to be ready to operate by harvest time.

PLYWOOD GLUE CONSUMPTION CENTERS IN NORTHWEST

Close to 99 percent of the nation's output of softwood plywood comes from 35 mills located in the Pacific Northwest, according to a recent release of the U. S. Bureau of the Census. One new mill began operations during the first quarter of the year. At least 97 percent of all softwood plywood is made from Douglas fir, the remaining 3 percent mainly being Ponderosa pine. Very small quantities of Western hemlock are used. Although production of softwood plywood has decreased since 1942, this has largely been a result of labor shortages and strikes.

Since 1942, moisture-resistant types (bonded principally with soybean and casein glues) have fallen from 85 percent

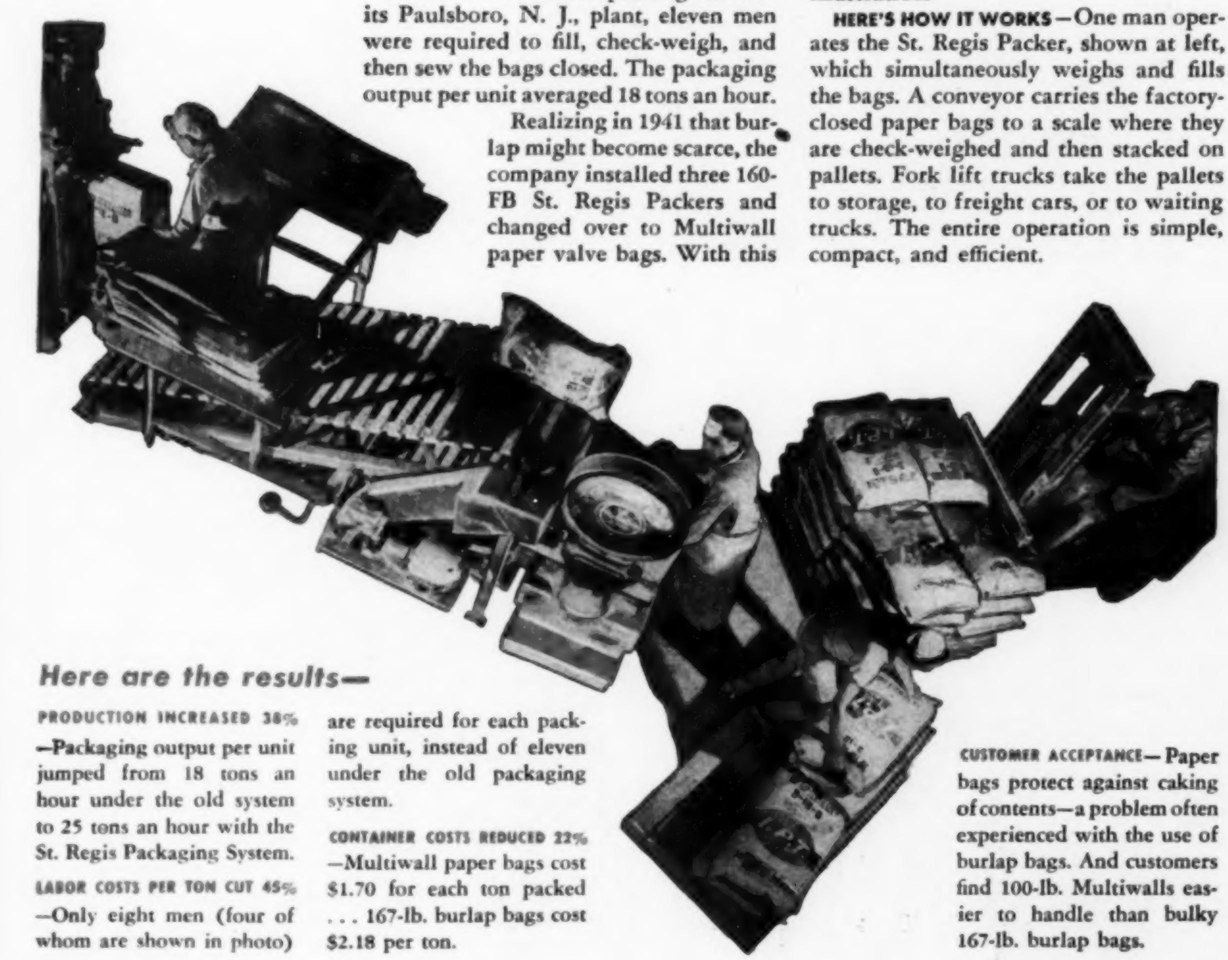
BIRDS EYE VIEW OF PACKAGING EFFICIENCY

Up to 1940, I. P. Thomas and Sons Co., of Camden, N. J., packed its mixed fertilizers in 167-lb. open mouth burlap bags.

At each of the three packing units in its Paulsboro, N. J., plant, eleven men were required to fill, check-weigh, and then sew the bags closed. The packaging output per unit averaged 18 tons an hour.

Realizing in 1941 that burlap might become scarce, the company installed three 160-FB St. Regis Packers and changed over to Multiwall paper valve bags. With this equipment as a basis, the company put into operation the highly efficient St. Regis Packaging System shown in the illustration.

HERE'S HOW IT WORKS—One man operates the St. Regis Packer, shown at left, which simultaneously weighs and fills the bags. A conveyor carries the factory-closed paper bags to a scale where they are check-weighed and then stacked on pallets. Fork lift trucks take the pallets to storage, to freight cars, or to waiting trucks. The entire operation is simple, compact, and efficient.



Here are the results—

PRODUCTION INCREASED 38%—Packaging output per unit jumped from 18 tons an hour under the old system to 25 tons an hour with the St. Regis Packaging System.

LABOR COSTS PER TON CUT 45%—Only eight men (four of whom are shown in photo) are required for each packing unit, instead of eleven under the old packaging system.

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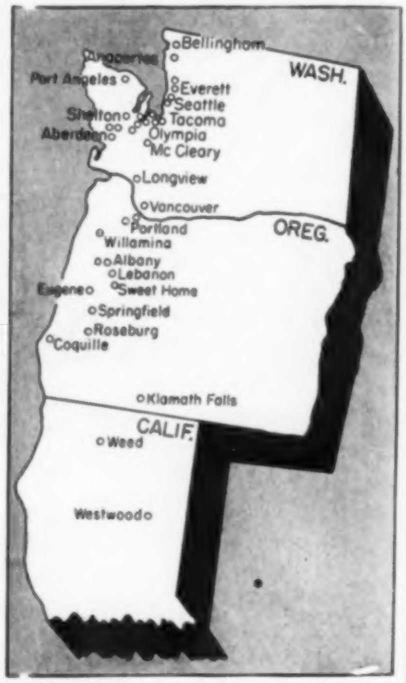
of total production to 70 percent in 1945. Exterior-type plywood is bonded with phenolic resin glue. During the past four years, there has been a decrease in "glue spread" (plywood produced per pound of glue used) from 35.3 to 30.8 sq.ft. for



moisture-resistant types and an increase from 15.7 to 18.8 sq.ft. for exterior types. The accompanying map shows location of the industry in the United States, while the table gives consumption of glues by types.

Glue Consumption in Northwest Plywood Mills[1]

	Thousands of Pounds			
	Casein	Soy-bean	Phenolic[2]	Total[3]
1942	3,595	37,380	17,262	61,736
1943	3,936	26,088	19,764	53,151
1944	1,935	27,879	23,067	55,941
1945	3,287	22,473	19,393	47,302
1946 (8 mo.)	3,448	14,567	15,921	35,062

[1] Softwood plywood. From Bureau of the Census. [2] Usually reported on a "wet" basis; all other types usually reported on a "dry" basis. [3] Difference between total and sum of three types represented by other types of glue.

HUGE CEMENT EXPANSION NOW UNDER WAY

Plans for a huge expansion program at Portland, Colo., and Devil's Slide, Utah, were recently announced by Ideal Cement Co., Denver. The program, already under way, is estimated to exceed $5,000,000. It is hoped that the new plants will be in production for the 1947 season.

At the Portland plant, a contract has been awarded Stearns-Roger Mfg. Co. for engineering and construction of a new crushing unit, cost of which will exceed $300,000. The new plant will be a complete unit with two wet process kilns 9.5 x 375 ft., each with a capacity of 2,000 bbl. daily. The present plant will be kept in full operation throughout the construction period and afterwards as long as the demand for cement requires. The new unit's capacity of 4,000 bbl. daily will more than double the present plant's output.

At Devil's Slide, detailed plans are

under way which involve practically a duplication in size of the new plant at Portland. The $2,500,000 Utah plant will be operated in conjunction with the present plant as long as the demand requires, thus increasing capacity about 3-fold. A new battery of storage silos and new packhouse will provide a capacity for 250,000 bbl. and permit simultaneous packing of as many as five types of product. Unprecedented demands for cement in the Rocky Mountain area, reflecting the rapid industrial growth of the region, prompted the firm's expansion moves.

WEST'S BENTONITE OUTPUT REACHES NEW HIGH

Almost 80 percent of the increased national output of bentonite in 1945 came from Wyoming, South Dakota and California, with the Wyoming-South Dakota area producing nearly 66 percent of the total. According to the U. S. Bureau of Mines, the national output in 1945 exceeded the 1944 tonnage by 5 percent and tripled that of 1938, marking the seventh consecutive, record-breaking year. Sales for use as a foundry-sand bond, down 11 percent from 1944, accounted for approximately 28 percent of the total; oil well drilling muds, up 34 percent, took a similar amount. A little over 25 percent was used in oil filtering and decolorizing.

Output of Bentonite, Short Tons*

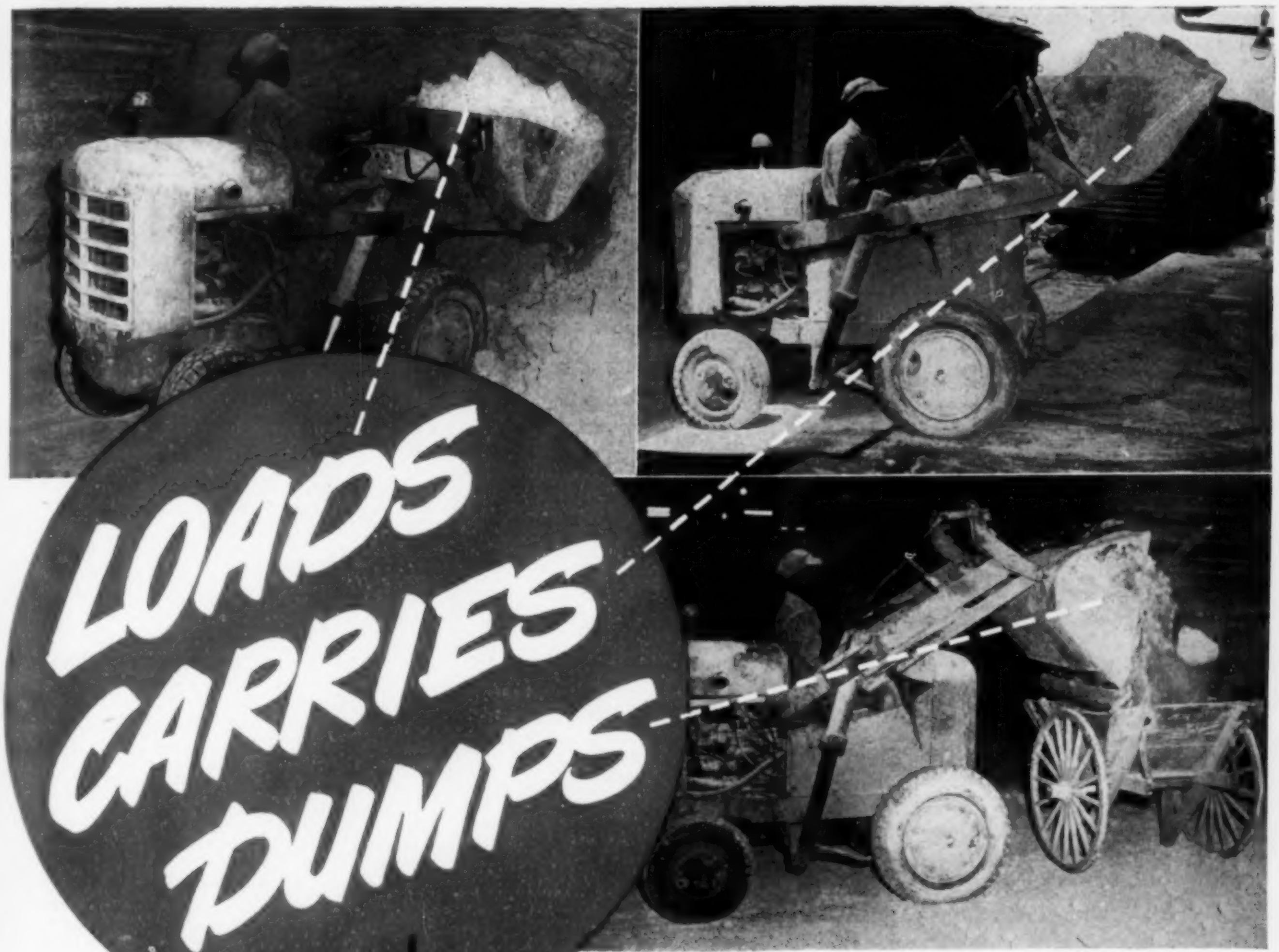
Year	Calif.	Wyo.	S. D.
1939	11,699	76,133	31,528
1940	7,867	91,714	40,481
1941	6,981	145,574	57,139
1942	4,745	139,410	88,149
1943	7,104	159,252	124,528
1944	6,649	196,138	169,893
1945	16,187	199,293	178,347

* U. S. Bureau of Mines. Does not include output of Arizona, Colorado, Montana and Utah, for which data were not given.

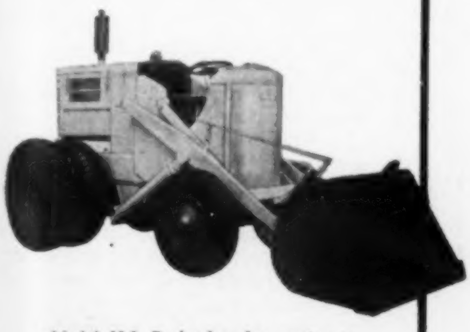
CLOROBEN SEWAGE TREATMENT PREFERRED TO CHLORINE

By court order, the city of Los Angeles and contributing communities are required to sterilize sewage before discharge into the ocean and to proceed at once with construction of a sewage treatment plant, estimated to cost $21,000,000. Since it will be at least two years before this plant can operate, the city has experimented to find a better and cheaper method than chlorination and to permit reopening of nearby beaches from the quarantine against surf bathing. According to the Los Angeles Bureau of Sanitation, the experimental use of Cloroben instead of chlorine probably saved the city about $180,000 during the past five summer months in which the court order was effective. This chemical, manufactured by the Cloroben Corp. of Jersey City, N. J., is a chlorinated benzene with two chlorine molecules in the ortho position and with added emulsifiers. It has a phenol coefficient of 13. However, due to its effectiveness in eliminating H_2S and slimes, the city has just decided to continue use of Cloroben during the winter months and throughout next summer.

Upon the performance of 50 dosing stations operating in June, it was shown that bacterial population of sewage was reduced 50-90 percent by use of 1 ppm.



Model H-A Payloader, 10½ cu. ft. bucket, gasoline powered — 2 speeds forward — 2 reverse speeds. 1 yd. bucket available for light materials.



Model H-L Payloader, for greater capacity and heavier duty service, 1 yd. bucket — gasoline or Diesel power. 8 forward speeds — 2 reverse.

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The HA Payloader will do the work of 8 to 10 men — handles 25 to 35 tons of chemicals per hour. One plant saved 28 man hours per car of chemical in labor costs alone—plus $75 per car through bulk shipment.

Over a quarter of a century of material handling experience has been built into the Payloader — more than 5,000 Hough units are serving industry throughout the world — cutting handling costs — saving labor — stepping up production. Let the Payloader take over your chemical handling problems — now, when production is vital, when labor is critical, when rising production costs are pinching profits. There is a Hough dealer near you to help in the solution of your material handling problems.

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Cloroben, 90 percent by 1.5 ppm., and 99 percent by 1 ppm. Cloroben plus 20 percent of the Cl_2 demand. Meanwhile, H_2S was reduced from 5-25 ppm. to 0.1 ppm. or less and grease, slime and bacterial growths adhering to sewer pipes were removed. Mosquitoes, flies and other obnoxious insects are also controlled by the chemical. Cloroben-treated sewage diluted with 100 parts of sea water in contact for 3-5 hr. increased bacterial reduction from 30 to 70 percent. At the last report, extreme ends of the bathing beaches were free from dangerous bacterial contamination.

Largely as a result of the promising work in Los Angeles, Salt Lake City began experiments with Cloroben during September. If the experimental treatment is successful, it will probably become a permanent procedure and may thus eliminate need for a $2,000,000 sewage disposal system in that city. Cost to Salt Lake City, it is estimated, may not exceed $50,000 yearly, including $36,000 for the sewer system and $14,000 for mosquito control.

FIRST WESTERN LATEX PLANT READY TO OPERATE

What will be the first latex manufacturing and processing plant west of the Rockies is now ready to be operated by American Anode, Inc., a subsidiary of B. F. Goodrich Co., in Los Angeles. The plant will produce liquid rubber and plastic latex material for sale to finished products users throughout the West, according to R. V. Yohe, president of American Anode. It will have an annual design capacity of 4,000,000 lb. of dry base in the form of liquid latex, which may contain up to 60 percent solids for synthetic and natural rubbers and 40 percent for plastics materials. Storage facilities will be available for 30,000 gal. of latex.

The unit, located near the B. F. Goodrich Co. synthetic rubber plant in Los Angeles, will have Robert A. Lees as manager. It will produce liquid latex for use in coating metals and wire, for impregnating paper, fabrics and textiles, and for the manufacture of various rubber goods.

NEW PLUTONIUM PROCESS STUDIED AT HANFORD

A new era of large-scale construction may possibily be in prospect for the atomic energy plant of Hanford Engineer Works at Richland, Wash., according to a recent release announcing the appointment of Dr. W. D. Coolidge as head of the General Electric Co. new atomic energy laboratory division. General Electric Co. took over operations of the plutonium plant on September 1. Evidently being considered is a radically new plutonium sepration process. Improvements in the chemical separation process have already increased the yield of plutonium and decreased consumption of process reagents.

Separation of radioactive isotopes on a plant scale has been started, it was reported. Small quantities of radio-iodine have been separated; larger quantities can be made available with minor changes in equipment. Neptunium, a transitional element in the conversion of uranium to plutonium, has

been separated and made available for scientific study in quantities never before achieved.

BARIUM INDUSTRY SHOWS INCREASED ACTIVITY

WESTERN producers of barite were active in seeking new deposits, and output of this mineral during 1945 increased in California and Nevada, according to the U. S. Bureau of Mines. Output in the latter state increased from 22,390 short tons in 1944 to 28,919 tons in 1945.

California-Nevada Barytes Mines division of Glidden Co., Oakland, reopened a mine at Tonapah, Nev., and the Chemical & Pigment division of the firm continued grinding activities and production of lithopone at its Oakland, Calif., plant. Barium Products, Ltd., of Modesto, Calif., a division of Westvaco Chlorine Products Corp., continued production of barite from Battle Mountain, Nev., and began operations at a mine near Greenville, Plumas County, Calif. This firm manufactures barium hydroxide, peroxide and other barium chemicals at its Modesto plant. Vernon Barium Products Co. of Los Angeles has evidently ceased manufacturing specialty barium chemicals.

The Industrial Minerals & Chemical Co., Berkeley, operated the Nelson mine near Carlin, Nev., in 1945. Baroid Sales Division of National Lead Co., Los Angeles, acquired the barite property of Industrial Minerals & Chemical Co. at Washington, Calif., and opened a new mine at Auburn, Placer County. This firm, which markets barite extensively for use in heavy-gravity oil well drilling muds, leased a deposit in Tulare County, Calif., and continued operation of the El Portal mine, Mariposa country. This deposit, first worked in 1920, has given the largest commercial production to date in California. The mineral is in part witherite. There is also a small and intermittent output of barite reported from deposits near Hailey and Troy, Idaho.

Largest newcomer to the western barite field is Arizona Barite Co., a subsidiary of Houston Oil Field Material Co., which has begun mining a property on the Salt River above the Granite Reef Dam. Also with

Western Producers and Processors of Barium Minerals[1]

Producing Firm	Location	Products or Activity
Arizona Barite Co.[2]	Mesa, Ariz.	Barite; grinding
Baroid Sales Div., National Lead Co.	Washington, Auburn, Calif.	Barite
	El Portal, Calif.	Barite, grinding
Barium Products, Ltd.[3]	Greenville, Calif.	Barite
	Battle Mt., Nev.	Barite
	Modesto, Calif.	Grinding; chemicals
California-Nevada Barytes Mines[4]	Tonapah, Nev.	Barite
Chemical & Pigment Div., Glidden Co.	Oakland, Calif.	Grinding; lithopone
Industrial Minerals & Chemical Co.	Carlin, Nev.	Barite
	Berkeley, Calif.	Grinding

[1] For the year 1945, as reported by the U. S. Bureau of Mines and private sources. [2] A subsidiary of Houston Oil Field Materials Co. [3] A subsidiary of Westvaco Chlorine Products Corp. [4] A subsidiary of the Glidden Co.

grinding facilities, this firm is now in operation with a capacity of 100 tons of finished product daily. A considerable part of the material is marketed in California.

Although drilling muds constitute the largest outlet for barite in California, as much as 35 percent of the state's output has gone into manufacture of lithopone and barium chemicals, according to one source. The attached table summarizes activities of western producers and processors of barite during 1945.

GLUTAMATE PLANT TO OPERATE SOON

Construction work is now progressing on the new monosodium glutamate plant of International Minerals & Chemical Corp. at San Jose, Calif., and it is expected that the unit may begin operations late this year. The entire project should be completed early in 1947. The plant will produce monosodium glutamate and related amino compounds from concentrated Steffens waste from beet sugar factories in California and Oregon. The San Jose plant, including pilot plant facilities and Steffens waste concentrating units at the sugar factories, will represent an investment of about \$3,500,000. Sufficient storage is being provided to permit year-round operation of the amino products plant.

The San Jose plant will be the first of its kind in this country; the firm's other glutamate plant at Toledo, which increased production some 80 percent last year, operates on grain proteins. Monosodium glutamate is widely used to impart a "meaty" flavor to certain foods. Before the war, world production was largely controlled by the Japanese.

THIRD ATOM-SMASHER BEING BUILT IN BERKELEY

Now under construction is the third of the atom-smashing machines at the University of California at Berkeley. Known as a linear accelerator, the 40-ft. experimental model will be used to bombard atomic nuclei with protons accelerated along the linear course of the machine's tube by scores of radar transmitters. Although the basic concept of the apparatus is not new, it will be novel in its source of power. Idea of using radar sets as a power source originated with Dr. Luis W. Alvarez, nuclear physicist at the Universty, who has charge of research and construction on the project. Funds were provided by the Manhattan District, while the Army Signal Corps provided several hundred surplus radar sets. Other atom-smashers at the University are the 184-in. cyclotron with its 4,000-ton magnet, which is nearing completion, and the McMillan synchroton (*Chem & Met.*, June 1946, p. 170), still under construction.

The linear accelerator consists essentially of two concentric tubes, the inner of which is approximately 1.5 in. diameter and cut into sections of different lengths separated by gaps. A Van de Graaff generator fires the proton bullets into the breach of the apparatus, at which time they also receive their first electrical kick from the radar power source. Within the tube, the bullets are protected while the electrical field alter-

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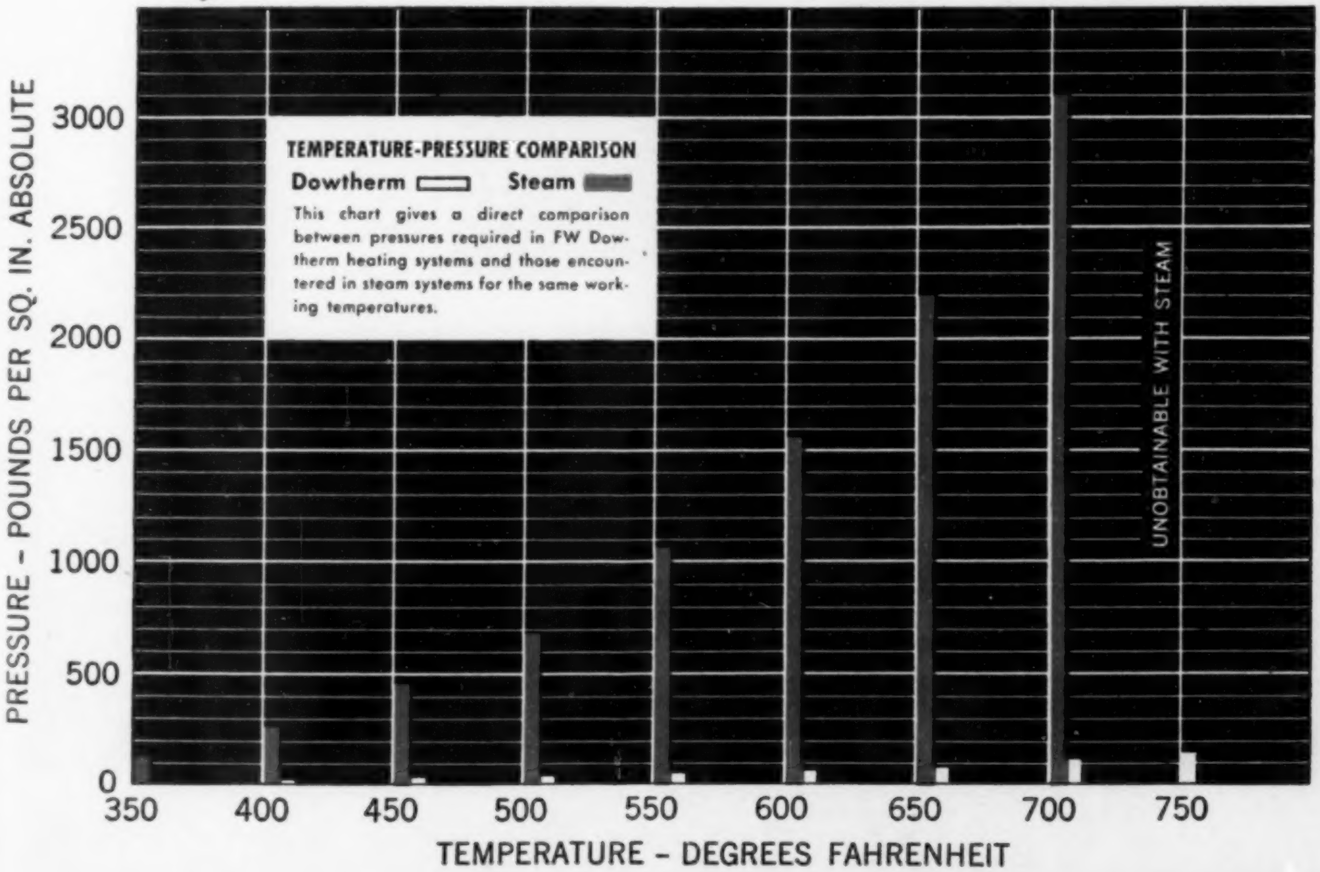

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nates. As they emerge from this section and cross the gap they are accelerated again and enter the next section, longer to provide necessary protection from the electrical field. The bullets finally crash the atomic nuclei target. If the 40-ft. model is successful, a 280-ft. tube may be built capable of accelerating particles to 280 million electron volts, which is the power range of the cyclotron and synchroton now building.

Scientists soon will have atom smashers powerful enough to duplicate the explosions carried on in nature by cosmic rays and hence may produce at will the mesotrons now found only in cosmic ray explosions, according to Dr. J. R. Oppenheimer. This would lead to a new era in atomic physics. According to Dr. Openheimer, the particles now known to be parts of the atom are the electron, proton, neutron, positron, mesotron, gamma ray and a hypothetical particle called the neutrino.

SULPHITE LIQUOR ALCOHOL OUTPUT INCREASED

Production of industrial alcohol from sulphite pulp liquors by Puget Sound Pulp & Timber Co., Bellingham, Wash., increased from 547,272 gal. for the first six months of 1945 to 748,055 gal. for the comparable period this year, according to a statement by the firm. The alcohol unit, only one of its kind in this country, began operations in March 1945. The plant has operated at a capacity of 6,500 gal. alcohol daily; with resumption of normal log production, it is probable that this rate will be increased.

In the second quarter of 1946, pulp production rose to 19,800 tons from 15,400 tons for the first three months, reflecting June production at 78 percent of capacity compared to an average of 52 percent in the first five months of 1946. A new hydraulic barker, installed in June, resulted in a 17 percent savings in log consumption in its first month's performance.

A new $460,000 paperboard mill, to be known as Bellingham Paper Products Co., will be constructed on Puget Sound Pulp & Timber Co. property and will be 75 percent owned by this firm. The new plant will consume an estimated 12 percent of the capacity output of the parent firm's pulp mill and will be capable of producing 45 tons of paperboard daily.

KAISER BEGINS PHOSPHATE FERTILIZER OPERATIONS

In response to the greatest demand ever experienced on the Pacific Coast for fertilizer materials, the Kaiser-subsidiary Permanente Metals Corp. has just begun commercial production of phosphate fertilizer at Permanente, Calif., under the name Thermo-Phos. The material is a new type of product made by electric furnace fusion of serpentine and phosphate rock. Two furnaces formerly used to turn out ferrosilicon for the Manteca, Calif., magnesium plant have been reconverted to produce the fertilizer.

Permanente is now producing 150 tons of Thermo-Phos daily and plans to increase output to over 200 tons daily as soon as sufficient labor can be obtained, stated

D. A. Rhoades, vice president and general manager of the corporation, who added that his firm entered the phosphate fertilizer field because of the local shortage and the fact that two-thirds of California's needs now have to be shipped from the eastern states and British Columbia. Immediate plans call for the marketing of Thermo-Phos in California only because local demands exceed Permanente's present capacity.

In describing the use of Thermo-Phos, Dr. A. C. Byrns, director of research of Permanente Metals Corp., explained that it can be applied directly to the soil, but that the major proportion is employed in mixed fertilizers. Unlike superphosphate, the new product contains an appreciable amount of magnesium. Raw materials are phosphate rock from Idaho and serpentine obtained locally.

LURGI PROCESS FUEL PLANT SCHEDULED FOR UTAH

Plans for construction of a plant in Salt Lake City to manufacture smokeless fuel from Utah coals were announced recently by Walter M. Russell, president of Utah Chemical & Carbon Co. Several types of smokeless fuels will be produced by the Lurgi process, and the firm expects to produce a large quantity of oils of importance in chemical markets. Harry W. Monahan, chief engineer and operating executive of the new company, stated that Utah coals are ideal for the Lurgi system and predicted that the firm's smokeless fuel will equal the best grades of Pennsylvania anthracite. More than 1.3 ton of coal would be required for each ton of briquets or char. J. L. Pritchard & Co. of Kansas City will have the contract for building the plant, but the site has not yet been selected. The company was incorporated by Grant MacFarlane, Salt Lake attorney and former president of the state senate.

CALIFORNIA SETS UP CHEMICAL ENGINEERING CURRICULUM

Under the direction of Dr. Wendell Latimer, dean of the College of Chemistry, the University of California at Berkeley is setting up a chemical engineering curriculum to meet the increasing needs of western industry for chemical engineers. The curriculum, being established in collaboration with the College of Engineering, is under the direction of Dr. Philip W. Schutz, formerly with Columbia University and the Manhattan District, as professor of chemical engineering. Dr. Schutz will be assisted by Dr. C. R. Wilke from Washington State College and by Mr. LeRoy Bromley, formerly with the Manhattan District. Further staff additions are anticipated as the curriculum is expanded and becomes more established.

At present, a four-year bachelor's curriculum and the master's degree are being offered in chemical engineering. The undergraduate course, in which unit operations are now receiving most emphasis, will use laboratory and equipment facilities of the College of Chemistry and the College of Engineering, but the degree will be given by the former. Graduate work, now limited to the master's degree, will be administered jointly by the two colleges

and will be primarily a research degree. Special courses such as in petroleum and metallurgical engineering will be given by the respective engineering departments. The chemical engineering curriculum now has about 45 junior and senior students and about 25 candidates for the master's degree.

CHEMICAL ENGINEERING EDUCATION — CORRECTION

In the September columns of this department the statement was made that the University of Washington and California Institute of Technology were the only schools in the West having chemical engineering departments accredited by the American Institute of Chemical Engineers. This was obviously an error. The chemical engineering department of Oregon State College, Corvallis, has been accredited by the AIChE since October 1942. Under the guidance of G. W. Gleeson, dean of the School of Engineering & Industrial Arts and head of the department of chemical engineering, the staff of Oregon State College has made notable contributions in chemical engineering, both educationally and in the field of applied research.

RECENT PROCESS INDUSTRY PLANT EXPANSIONS

Salt—Construction of a \$500,000 addition to the plant of Leslie Salt Co., Newark, Calif., got under way recently to replace equipment of the Arden plant. The new unit will have an annual output of 100,000 tons; completion will require about six months.

Wood Flour—Specialty Wood Products Co. has begun operations of a new plant at Yardley, Wash., which has a capacity of 50 tons of wood flour daily. The product is used largely as a filler by eastern producers of plastic materials and asphalt roofing.

Process Equipment—Blaw-Knox Corp. of Pittsburgh, Pa., has purchased a 26-acre site north of Santa Clara, Calif., and intends to erect a \$1,000,000 plant to manufacture processing and road building equipment.

Insecticides—San Francisco Sulphur Co., Berkeley, Calif., a subsidiary of Stauffer Chemical Co., has been granted CPA permit to erect a \$57,000 new plant adjoining present facilities in Berkeley for increasing production of insecticidal sulphurs.

Wood Pulp—Construction to house an eighth digester and provide additional chip storage is under way at Rayonier's Port Angeles, Wash., pulp mill as part of the company's \$4,000,000 plant improvement program. The firm produces a high-grade cellulose pulp.

Refinery—Articles of incorporation of the Phoenix Refining Co., Phoenix, Ariz., have been filed and plans to build and operate an oil refinery announced. The proposed refinery will have a capacity of 5,000 bbl. of gasoline and 1,500 bbl. of asphalt daily. Crude oil will be piped from west Texas by Arizona Pipeline Co.

Precious Metals—Handy & Harman, New York, refiners and processors of precious metals, has announced that a new plant is being built in Los Angeles to serve the Pacific Coast. The new unit is expected to start operations within a month or so.

Superphosphate—Stauffer Chemical Co. has announced a \$145,000 expansion program at the Richmond, Calif., plant which will essentially double capacity of the unit to produce superphosphate. Construction is now getting under way. Stauffer, only producer of superphosphate on the West Coast, has a similar plant near Los Angeles.

N E W S F R O M A B R O A D

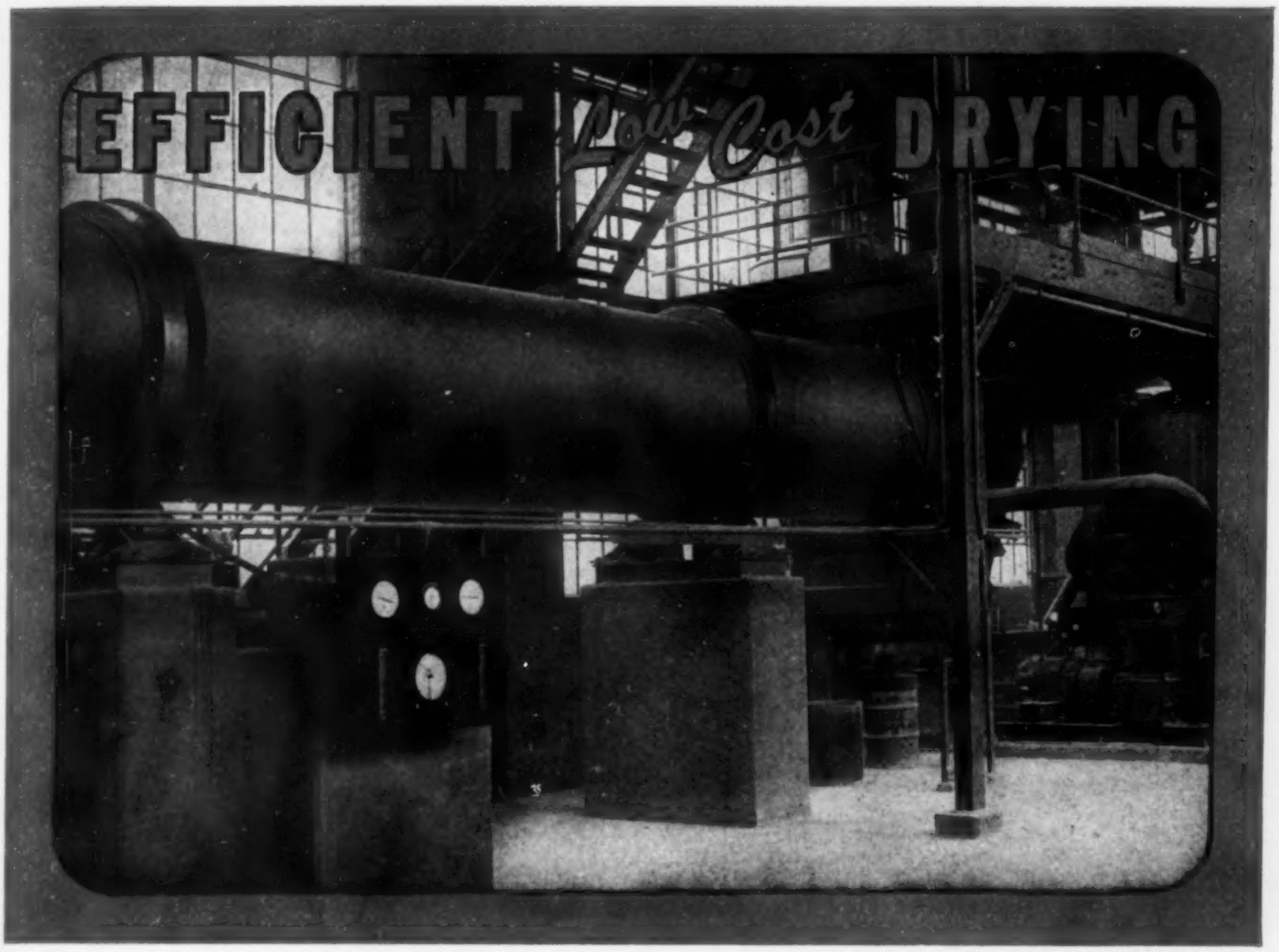
CHEMICAL EXPANSION PROGRAMS IN GREAT BRITAIN FACE LABOR AND PLANT SITE PROBLEMS

Special Correspondence

In the past twelve months most of the leading chemical companies in the British Isles have announced far-reaching extension and modernization programs. Imperial Chemical Industries, Ltd. has a provisional program of capital expenditure for the next eight years involving investments of over £40,000,000. Plans of companies with less extensive activities are proportionately smaller but not less ambitious. Courtaulds and Celanese are expanding their rayon and plastics production, Imperial Smelting and Fisons, pigments and fertilizers, Pinchin Johnson and Goodlass Wall, paint manufacture.

In the pharmaceutical and plastics trades many new ventures are under way; on penicillin plant alone more than £3,000,000 has been spent so far. Outside firms, like Distillers Co., the leading British alcohol producer, are entering the chemical field as producers. Specialty oil refiners and coal distillers are developing their chemical business. A new firm, Petrocarbon Ltd., intends to spend nearly £2,000,000 on a plant for extracting aromatic hydrocarbons from oil products in the next two years. Though precise figures are lacking, it seems likely that on the most prominent of these new chemical works a total sum exceeding £10,000,000 will be spent each year, possibly for a decade or longer.

These new plants are likely to revolutionize Britain's chemical industry. Some 10,000 additional workers will be needed annually merely to staff new factories, to say nothing of those needed to make up for natural loss of labor. The capital outlay of about £1,000 per worker envisaged in some typical new plants is substantially higher than what was usual before the war; as evidence of progressing mechanization of producing processes especially in the heavy sectors of the chemical industry it raises important problems of finance and labor policy. 'Cheap money' and mounting wages place a premium on labor-saving by costlier plant, especially if full-capacity production is assured but high depreciation rates due to the swiftness of technical advance largely offset this advantage. Nevertheless British chemical manufacturers favor mechanical methods; for the shortage of labor is expected to last for some time, chemical factories are not generally popular with women workers, and wages are unlikely to recede from their present high level. Shortage of labor also makes for



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dispersal of new plant, as firms hitherto concentrating on one locality have experienced difficulties in obtaining female labor and skilled men.

The tendency towards dispersal which is a feature of new plant construction at the consuming end of the chemical industry, in the pharmaceutical and cosmetical trades, but also in paint and fertilizer production, however is primarily due to increased costs of transport. Railway charges in particular have gone up substantially. Many firms can make use of alternative accommodation secured during the war. Besides, it has been found that dispersal helps to keep down stocks required to assure regular distribution. Preference for previously neglected areas is also partly due to availability of idle war factories which can be leased on favorable terms and to official advice concerning plant location; in these areas construction materials and building labor are usually not quite so short as in more active population centers. Building licenses for new factories are easier to obtain, and the local authorities on whom so much depends nowadays are more likely to be helpful.

SHORTAGE OF COAL

More crucial than labor shortages, transportation costs and construction licenses is the problem of assuring adequate coal supplies. It is widely believed that owing to larger calls from industry, reduced mine-head and trade stocks and lower outputs, all factories will not be able to cover full requirements this winter. Some chemical works have followed the government advice and switched over to oil where coal is not indispensible, but the capital outlay for oil burners is about double that for coal burners. Other factors also mitigated against change-over in boiler and power plant at short notice. It is already reported that some makers of heavy chemicals have had to cut production owing to lack of coal, and the Minister of Fuel has appealed for a voluntary cut in industrial and domestic fuel and power consumption by 10 percent this winter.

If the winter is normally cold, output cuts will hardly be avoidable, and it is generally agreed that recruitment of outside labor for the mines and other drastic expedients will not yield any early results. When the National Coal Board takes over the nationalized colliery industry at the beginning of next year, it will be faced with difficulties which must be tackled at once, and it is by no means certain whether the long-term problem of supplying coal in good quantity, in proper quality and at reasonable prices will be solved to general satisfaction. The biggest chemical producer in the country is now paying £3,500,000 more for its coal and coke than before the war. It needs little imagination to visualize the consequences of insufficient coal supplies and excessive coal prices for the chemical industry.

Although the need for economy in use of coal and the widest possible development of coal processing to save fuel is obvious, little progress has been made in modernization and extension of the coal distilling industry. Little has been heard of projects for the erection of new coke-

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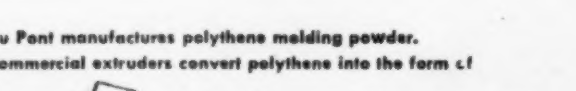

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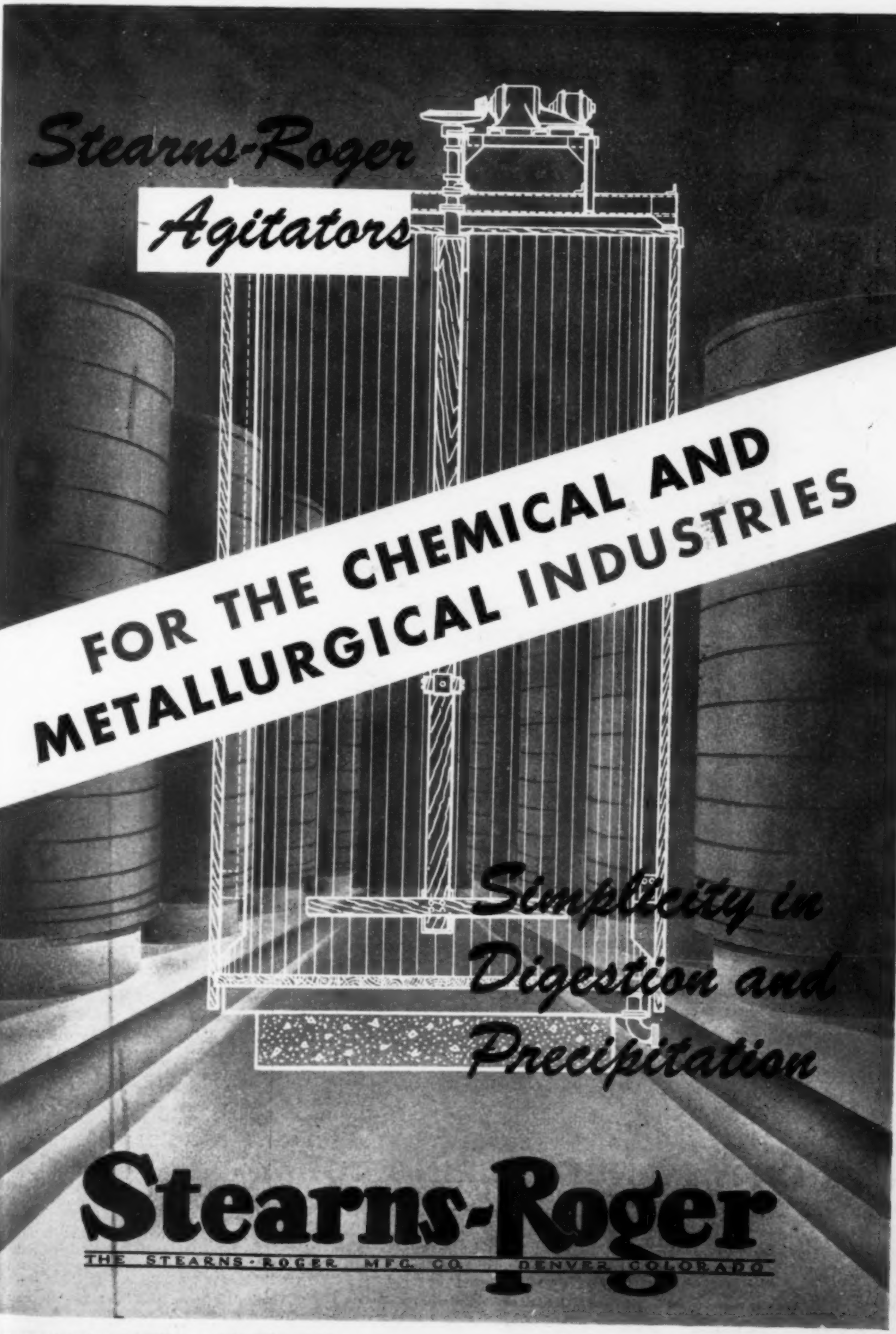
oven plant since the end of the war, and the very progressive low-temperature carbonization enterprise has not formulated any new plans this year. On the other hand, new designs promising great economies in coal are in the blue-print stage. Private managements are unwilling to risk large new investments while nationalization is pending and its repercussions on carbonization works scheduled to remain outside the Coal Board's sphere of control are uncertain.

In these circumstances it is worthy of special note that the largest single new enterprise yet announced is the ICI £10,000,000 heavy organic chemicals plant for which a site is now being prepared at Wilton near Middlesborough; it thus appears that the long-term outlook as regards coal supplies in this important field is viewed with confidence. Even those whose aim it is to build up an organic chemical industry on imported petroleum admit that the coke-oven industry is likely to remain the chief raw material support of this branch of production. The big plant which Petrocarbon Ltd. intends to erect at Partington near Manchester for a throughput of 50,000 tons (later possibly to be doubled) of naphtha or gas oil and perhaps shale oil and low-temperature carbonization products is not expected to do more than make a small contribution to Britain's supply of aromatic organic chemicals, which however will be doubly welcome because the output of different products can be varied to meet changes in market requirements and the residual gas mixture contains a high proportion of olefines for further treatment.

WAR PLANT CONVERSION

As construction of new factories meets with considerable difficulties owing to the building industry's preoccupation with dwelling houses, there has been comparatively more news concerning conversion of war factories to peacetime use than there is regarding entirely new works. A big plant just opened by Dunlop at Speke, Liverpool, is perhaps typical of larger factories of this type. In a relatively short time Dunlop adapted this huge factory to its own needs. Even so the capital outlay was several million pounds sterling for a plant which now employs 4,000 workers and will eventually give work to 6,000-7,000. Straight flow production has been assured by maximum use of mechanical devices (all mixing operations and the weighing of carbon and lamp black, etc., are carried out by machine), but difficulties are still being experienced through shortage of raw materials, even though rubber itself is not in short supply. The plant is capable of processing and manufacturing operations permitting continuous production from the crude rubber to finished tires and footwear.

Liverpool is also the location of other new chemical works, including the first deep-fermentation penicillin plant which is operated by Distillers Co. Port towns have been chosen for many new chemical factories, especially in the heavy section where access for ocean-going vessels is of great advantage. Lancashire in the northwest and the Newcastle and Dur-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ham areas in the northeast are favorite regions for new chemical works also because of the availability of coal and labor, while firms with principal factories in southern towns, at Nottingham, Coventry and London, tend to spread their manufacturing activities.

One interesting aspect of the location of new chemical factories is the provision for later extensions and for customers who may wish to erect plants near their raw materials source. Availability of both coal and salt near densely populated areas close to the sea gives a natural advantage to some English counties, but in other cases importers of foreign commodities, such as mineral oils, pyrites and zinc concentrates, and oilseeds, have been able to attract manufacturing industries because of cheap byproducts they are able to offer for other chemical manufactures. In some instances government support has caused chemical manufacturers to build plant in otherwise neglected areas, thus providing an outlet for local raw materials and labor; the young Scottish seaweed industry is an example of the possibilities opening up, but also of the unexpected difficulties encountered, when official encouragement is given to the development of indigenous raw material resources.

It is probably true that at no time between the two wars was there so much initiative and long-term planning in Britain's chemical industry as there is now. Whether all these new factories will be able to withstand the severe climate of international competition when the present sellers' market comes to an end remains to be seen. It is to be noted that none of the factories are meant to work exclusively or predominantly for exports. Their basis will be the home market, but their geographical position and production conditions will enable them to avail themselves of opportunities in foreign markets.

Some British chemical manufacturers hope to take over a substantial part of the export business of German prewar manufacturers, and the export returns so far seem to justify their confidence. It may be said that compared with other British industries the export business of the chemical trades rests on sound foundations. More recently, however, increases in cost elements have forced many makers to revise their calculations, and this may have adverse repercussions. For the time being the outlook remains good.

BRITISH PLANT WILL USE CATAROLE PROCESS

An estate of 700 acres at Partington, adjoining the Manchester Ship Canal, has been purchased by Petro Chemicals, Ltd. a new company formed to produce chemical materials from petroleum. The venture is financed by $7,200,000, of which one half has been subscribed by the Finance Corporation for Industry and the other half by a group of private financial institutions. The plant, which will produce from oil a wide range of liquids and gases used in making of paints, dyestuffs, plastics, and other products, is intended to form the nucleus of a large industrial estate composed mainly of plants using some of its products. The new plant will be based on the "Catarole" process.

SCARCITY OF RAW MATERIALS RESTRICTS ACTIVITIES IN CHEMICAL INDUSTRIES OF SOUTH AFRICA

Special Correspondence

WORK HAS started on extensions, estimated to cost nearly £1,000,000, to the African Explosives and Industries fertilizer factory at Umbogintwini in Natal. It will be one of the biggest in the world when completed at the end of next year. Output will be increased to 320,000 tons of superphosphate—more than four times the 1938 output, and it is expected that South Africa will have 500,000 tons of fertilizer available by the end of next year. The balance of 180,000 tons will be produced by the company's factory at Somerset West, near Cape Town. When the war curtailed imports of fertilizer, South African factories reached a production peak of 300,000 tons, which cannot supply current needs.

A recent private investigation into the possibilities of extracting oil from South African shale deposits by the electrothermic process developed by the Swedish engineer, Dr. F. Ljungstrom, revealed that in certain circumstances the process could be used economically in the Union. A statement issued by the Swedish Consulate in Pretoria says it appeared that seams of oil-shale in the Transvaal were covered by a very thick layer of sandstone. A depth of about 55 yards had to be penetrated before borings reached the oil-bearing shale, which was at the most about 12 yards thick. Dr. Ljungstrom did not consider this exceptionally favorable for the process he had developed. The covering layer should not be more than 12 to 18 yards thick, and a heavier seam of shale of from 18 to 23 yards would be desirable. But the average percentage of oil in the Transvaal shale was estimated at 10 to 15 percent, against only 5 percent in Sweden, and he therefore considered it possible to start economic production based on 12 yards of shale covered by about 23 yards of sandstone.

If the oil shale in the Transvaal yielded, when gasified, equal calorific values of gas and oil, it should be possible to produce all the electric energy needed for Dr. Ljungstrom's process of heating the shale by using the gas in a power station. The report states: "Dr. Ljungstrom considers that to form a definite opinion of the economic possibilities of oil production from the shales of the Transvaal it would be highly desirable for a closer geological investigation to be carried out.

The possibility of establishing an organic chemical industry in the Union was discussed in a paper by Dr. S. R. Haas, chemical engineer, read at the conference of "Science in the Service of South Africa" at the University of the Witwatersrand. He said at the moment South Africa had only two branches of the organic chemical industry which were well developed. These were the manufacture of explosives and of chemicals based on alcohol and by-

products. The remainder of the organic chemical industry was actually only a "mixing" industry which depended on materials from overseas. There seemed to be a reluctance to discuss the idea of an industry based on indigenous raw materials. Objections were that the country had a limited consuming power for such products and that coking coal deposits were small. The answer lay in creating a demand for the products, and using the large deposits of low-grade coal. The Fischer process had proved that low grade coal could produce a full range of organic compounds—even including, before the war, the production of petrol at 6d. a gallon.

Owing to the action of the Soviet Union in buying all Argentina's supplies of linseed oil, and the trade ban with India, South Africa faces a serious shortage of paint in the next few months. Supplies of linseed oil are low and the price rose by 2s. 6d. a gallon recently. It is said that the Russians sent two tankers to the Argentine and bought up 20,000 tons of linseed oil. Uruguay manufactures linseed oil, but South Africa cannot obtain those supplies because Uruguay is in a United Kingdom purchasing area.

SOAP PRODUCTION CUT

South Africa's largest soap-makers, who have their main factory in Durban, have had to cut production by nearly 50 percent owing to the shortage of oils and fats. This information was given by the chairman of the company in Durban. South Africa used to get most of its oils and fats from India and the Belgian Congo, he said. Now India, owing to its own shortage, had stopped exporting groundnuts. The Belgian Congo supplies go into a central pool and are allocated by the Combined Food Board in Washington. South Africa's allocation has been cut sharply. Raw materials for soap and foodstuffs were largely interchangeable. A large proportion intended for soap-making had been diverted and after being refined and treated were used for edible fats. The company is operating its own rationing scheme. All customers have had their orders cut down in proportion to the amount the factory is able to produce.

A new promotion is the National Match Co. Ltd., with an authorized capital of £250,000 in 1,000,000 5s. shares, of which 600,000 have been issued and 160,000 are being offered for public subscription at 8s. 6d. Apart from its interest in the manufacture of matches the company will have an interest in another company formed to manufacture cardboards and insulating boards.

All stocks of poison gas in the Union have been destroyed. With the destruction by burning in blast furnaces of the remaining gas bulk stocks and the dismantling of gas equipment at the two factories, the only mustard gas now anywhere near the Union is the consignment dumped off the Port Elizabeth coast. Chemical warfare plants in the Union were constructed during the war for the British Ministry of Supply for the purpose of manufacturing poison gas. It took 14 months to destroy the mustard gas stocks, a hazardous operation carried out without any casualties.

Large-scale experiments initiated by the Minister of Health are taking place at commercial mills on technical problems involved in fortifying maize-meal with food yeast. If success is achieved steps will be taken to produce sufficient food yeast to fortify maize-meal on a large scale. The secretary for public health says these experiments and the requirements of hospitals and allied institutions, which are also experimenting on the best methods of its utilization, will absorb all the food-yeast surplus for some time to come.

The fertilizer shortage is still serious with little hope of immediate relief, said the Controller of Fertilizers. There is a possibility of increased allocations of phosphates next year for those who apply, he said. No nitrates had reached the Union since July. The potash shortage also was serious. The shortage of fertilizers was aggravated by the shortage of bags.

SEAL OIL REFINERY

As a result of investigations carried out at the Cold Storage and Dehydration Laboratories in Cape Town, a pilot plant is being installed in the new sealing vessel Gamtoos to extract refined oil from the blubber of seals. It is intended to solve equipment that will enable a high-grade seal oil to be refined on board the ship. This oil would be suitable for the manufacture of margarine as well as for cooking purposes. It is also hoped that a process will be found for reducing the seal carcasses to cattle feed or fertilizer. New products to emerge recently from the government dehydration headquarters in Cape Town are dehydrated soup pulps and puffed dehydrated potatoes.

Addressing members of the Cape Industrialists' Association recently, an official of the South African Bureau of Standards said a national committee was being set up to investigate standardization of containers. He said the bureau's laboratories had been established, the meteorology laboratory was in use, and part of the chemical laboratory was expected to be in operation in the near future. It also was planned to set up laboratories for testing electrical meters, automobile batteries and electric lamps.

Increasing emphasis on prefabrication as the only practical solution to the housing program has stimulated interest in the potentialities of vermiculite, one of the most promising materials found in commercial quantities in South Africa. The manufacture of vermiculite products was started at Industria, Johannesburg, by South African Vermiculite and General Industries, registered in May, 1944, with a capital of £50,000.

It was considered that vermiculite, which is sound-proof, heat-proof, rot-proof and vermin-proof, had an important role in the rising demand for lightweight concretes, prefabricated materials and plastics of all kinds. Production was concentrated initially on flooring, refrigeration and other insulation products, and refractories, while attention also was devoted to the large-scale production of pre-cast, lightweight concrete slabs. Vermiculite is the basis of a prefabricated housing project undertaken by Kimlite Industries, also of Johannesburg. After a large amount of experimental

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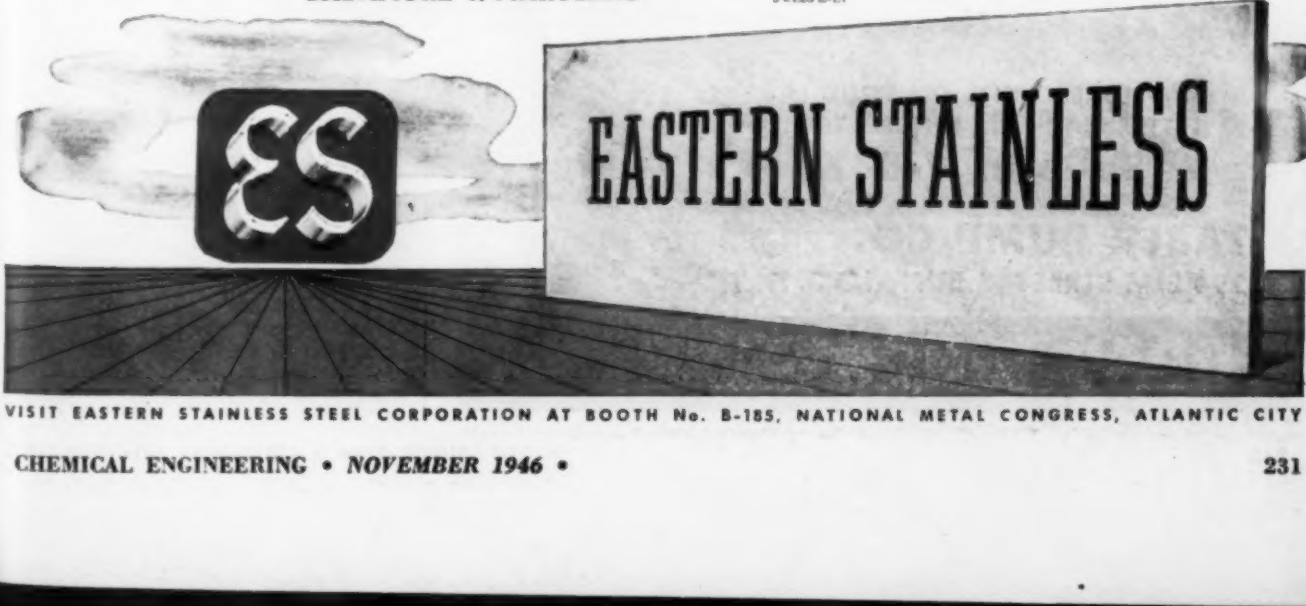

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work, Kimlite Industries has developed and patented suitable binding materials which, mixed with vermiculite, give a block or slab with high crushing strength, high heat insulating value, and when suitably surfaced, weather resistance combined with attractive appearance.

A big new abattoir planned for Johannesburg, as a result of recommendations made by the commission which investigated slaughter houses and cold storages throughout the Union in 1944 and 1945, is likely to engage experts from overeas to advise on the making of valuable drugs and medicines from the various glands recovered from slaughtered stock.

Fears that diminishing coking-coal resources might necessi'te a retardation in local iron production have been proved groundless. Investigations into methods in use in Sweden since 1926 for the production of iron direct from its ores, without the use of coke, indicate that South Africa need have no qualms about producing to the limit of her capacity, for the improved direct reduction methods make use of ordinary coal, colliery slack, or anthracite, none of which need be converted to coke before use. The supplies of coking coal in the Union are very limited, and consequently increasing interest is being shown in these iron and steel developments.

The possibility of khaki bush, regarded as a noxious week, being cultivated in South Africa, is envisaged by a Pretoria research chemist, who has perfected a method of recovering oils from the weed. He stated that he had heard that some farmer made a very effective dip from khaki bush by boiling green weed in water and using the infusion in the cattle dipping tank. Following up this clue, he found the plant contains an oil which insect pests, such as ticks and fleas, will avoid. He found that by a treatment with benzine, followed by distillation, the oil can be recovered, and that it formed a powerful insecticide. Further experiments revealed this oil as possessing remarkable frothing properties.

SWISS INSTITUTE TO TEACH CHEMICAL ENGINEERING

Last spring the pharmaceutical concern, F. Hoffman-La Roche & Co., Basle, Switzerland, celebrated its fiftieth anniversary. This coincided with the half century jubilee with the company of Dr. Emil C. Barell, its president and chairman of the board of directors. The firm was established by Fritz Hoffman-La Roche who was its president until his death in 1920. Then Dr. Barell assumed the presidency and under his guidance the firm grew to be not only the oldest but also the largest concern in its field in Switzerland with affiliates in most countries throughout the globe.

Dr. Barell, who for the past five years has been connected with company's plant in Nutley, N. J., returned to Switzerland for the double celebration and made the occasion memorable by setting up two funds, one with a capitalization of one-half million dollars to offer financial aid to scientists at Swiss universities for group research on special problems in pharma-

ceutical research; the other, amounting to one-quarter million dollars, for "The Emil Barell Fund for the Training of Chemical Engineers" Money from the latter fund will be used to establish a course in chemical engineering at the Swiss Institute of Technology in Zurich, the course to be based upon the American pattern.

DUTCH CHEMICAL INDUSTRY GIVEN FINANCIAL AID

Up to the end of September, the Netherlands Bank for Reconstruction had granted credits in the amount of $1,935,000 to the Dutch chemical industry. The Bank, similar to the RFC in the United States is aiding in the rehabilitation of Dutch industry. But aid is being provided by participation with private firms, rather than by the nationalization of the country's industries as in some other European states.

The Reconstruction Bank (Finance Corporation for Netherlands Economic Reconstruction, Limited) was established in the Hague on October 31, 1945, with resources provided by the Royal Netherlands Treasury, the Netherlands Bank (since nationalized), the big joint-stock and private bank, the two central agricultural banks, and by a large number of insurance companies, investment trusts, savings banks, and pension funds.

Primary purpose is to provide funds for rebuilding war-shattered industries, for normal re-equipment, expansion and development, and for new enterprise. Additionally, the bank acts on behalf of the Treasury in making government war damage payments. Its field of activity extends to all aspects of trade, commerce, and industry both in the metropolitan and overseas territories, but in practice it confines itself largely to manufacturing and the primary industries.

Total credits granted amounted to $17,600,000 in September. A total of $26,400,000 had been distributed by the same date on account of war damage claims payable to the government. The credits on which agreement is about to be reached, plus financial aid requested recently, amount together to $43,000,000, which suggests that within several months the total transactions of the Reconstruction Bank may top $85,000,000.

One of the bank's chief contributions is in stimulating industries designed to supply home and export markets which were formerly dominated by German goods. Textiles and dyestuffs have received particular attention.

American interests have also been active in the expansion of Dutch industry. B. F. Goodrich Co. has completed arangements for a factory with an annual output of 100,000 tires, while U. S. money is reportedly involved in the recent establishment of the Netherlands' first plastic industry.

ADVISER TO CZECHOSLOVAKIA CHEMICAL INDUSTRIES

Announcement is made by the London office of McGraw-Hill World News to the effect that Dr. George Lewi, A.F.C.D.I., industrial consultant, London, has been appointed chemical advisor for

the United States and the British Empire to the directorate of the nationalized chemical industries of Czechoslovakia. David Lee, A.B.I.C., formerly personal assistant to the controller of chemical defense development at the Ministry of Supply, is now associated with Dr. Lewi.

LARGE AMMONIUM SULPHATE PROJECT IN INDIA

Construction is about to get under way on the huge $30,000,000 ammonium sulphate fertilizer factory sponsored by the Indian Government at Sindhri in the Province of Bihar in Eastern India.

The government has announced that approximately $10,000,000 worth of plant equipment in the form of boilers, gas compressors, gas plant and turbo-alternators already has been ordered from abroad, mostly in Great Britain, and that certain other heavy equipment will be imported later.

To encourage Indian manufacturers a wide range of equipment and machinery will be purchased from within the country, however, and the government is seeking bids from domestic firms for such needs as structural steel, water mains, piping, and certain types of electrical equipment.

The Central Government Public Works Department is about to start work on the construction of factory foundations, roads and drainage systems as well as the erection of a special village to house the staff of the factory. Meanwhile the Bihar Public Works Department has been assigned the development of the water supply scheme.

NEW PLANT IN SOUTH WALES FOR MONSANTO LIMITED

Construction of a new organic chemicals producing plant in Newport, Monmouthshire, South Wales, is planned by Monsanto Chemicals Limited. A 125-acre site has been acquired for the new plant, and full-scale production is planned for early 1948. More than half of the new plant's production will go into exports. The Newport works, to employ between 500-600, is only part of a $10,000,000 expansion program which Monsanto has under way, which also involves plant extensions and a spacious research and development laboratory at the principal plant at Ruabon in North Wales.

NETHERLANDS EAST INDIES CLOSED TO BUSINESSMEN

The American Consulate General at Batavia, Java, reports that American businessmen have not been granted permission to visit the Netherlands East Indies in appreciable numbers. Those admitted are, for the most part, representatives of American firms which were established there before the war. At present all foreign trade has been taken over and is operated by the government through the NIGIEO (Netherlands Indies Government Import and Export Organization). All exports are sent to the Netherlands Purchasing Commission in New York and conversely imports are shipped by

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the Commission on orders from NIGIEO. This situation is expected to continue until the end of the year. Batavia is crowded and accommodations can be obtained only for a limited number while it is practically impossible to visit points outside Batavia as connections with other cities are entirely by air and priorities are granted only in cases of urgent necessity.

NEW COMPANY TO MAKE HEAVY CHEMICALS IN INDIA

WRITING from Calcutta, McGraw-Hill World News reports that the latest entrant into India's budding heavy chemicals industry is Ispahani Chemicals Ltd., with an authorized capitalization of approximately $3,000,000, which now is offering shares to the public.

The new firm proposes to produce sulphuric acid and caustic soda at a plant to be built in the outskirts of this city. Purchase of a sulphuric acid plant complete with all incidental machinery and apparatus manufactured by the Monsanto Chemical Co., St. Louis, already has been arranged. The plant has a 10-ton daily capacity. Negotiations now are underway for the acquisition of a caustic soda plant of the electrolytic type with a daily capacity of 5½ tons of caustic soda and 5 tons of chlorine.

Ispahani also plans to develop the production of byproducts and subsidiary chemicals. Its management is in the hands of a group of well-known Calcutta industrialists.

SULPHUR WELLS DRILLED IN VERA CRUZ, MEXICO

MEXICAN GULF SULPHUR Co. and the American Sulphur Co. S. A. (a Mexican corporation), have completed the drilling of four important sulphur wells in the Province of Vera Cruz, Mexico, according to an announcement by Eugene L. Norton, president of Mexican Gulf Sulphur. The wells have proved up what is apparently a very large new deposit of salt dome sulphur, he added, similar in nature to the large deposits now being mined on the Gulf Coast of Texas and Louisiana.

INDUSTRIAL LABORATORIES TO BE BUILT IN MEXICO

THE Mexican Minister of National Economy, engineer Gustavo P. Serrano, just made public that the President of the Republic signed a decree approving the setting up of two buildings in Sotelo Heights, near Mexico City, destined to house laboratories for industrial testing and experimenting. The two buildings will cost $60,000. This sum has been collected from industrialists.

The Federal Government will donate the grounds, water and electric supply for the works. One of the laboratories will serve for the testing of and experimenting with products manufactured out of Mexican hard fibers such as henequen (sisal), palm fiber, etc. In the other, experiments and tests with oils, soaps and candelilla wax will take place.

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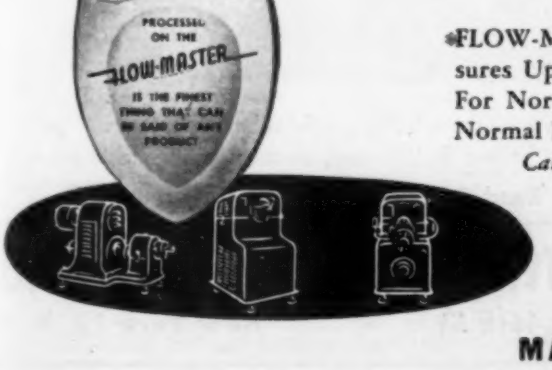

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Miscellaneous Secret Correspondence Concerning Work in Progress—This important secret file contains among other chemical and metallurgical projects which were in process for the German High Command (OKW) the following reports: (1) Kaiser Wilhelm Institut fur Physikalische Chemie und Elektro-Chemie, Berlin-Dahlem, Faraday Way 4-6, reports on a complete card index compiled by Dr. Trude Langer on material for chemical warfare from 1897 to date of report—July 26, 1943. (2) School for Technology, Stuttgart, Schellingstrasse 26; reports by Prof. Dr. R. Fricke, July 1943 on "Hopcalithen" a chemical against carbon monoxide, developed to perfection by the Russians, and on a fire starting substance which cannot be extinguished by water or sand. (3) University of Graz, Austria, a report by Prof. G. Tantsch, Sept. 1944 on the dialysis of thorium and other metallurgical and chemical problems. (4) University of Leipzig, a report by Prof. Wo. Oswald, July 1943 on how to prevent lubricating oil from foaming in airplane motors. (Germany. Reichsforschungsrat, PB 20484; 1938-1944; 125 p.; M. $1.50; P. $9.)

A German Thermometer for Use in the Range 400-1,200 Deg. C.—The thermometer, calibrated from 400 deg. C., proved to be constructed in silica, filled with gallium, and provived with a hydrogen atmosphere above the gallium. The maximum error was −23 deg. (at 500 deg. C.), but in the range for which it was being used at the V. A. W. Lippewerk, 950 deg. to 1,000 deg. C., the error was uniformly +50 deg. C. Diagrams of the thermometer and a bibliography are included. (C. J. Smithells, BP 25550; Feb. 1946; 12 p.; M. $1; P. $1.)

Synthetic Tanning Agents and Leather Auxiliary Products of the I. G. Farbenindustrie—This report describes the results of an investigation of the I. G. Farbenindustrie regarding the manufacture of synthetic tanning agents at Hoschst, Ludwigshafen and Leverkusen. The investigation disclosed that I. G. Farben manufactured large quantities of synthetic tanning assistants and tanning agents both before and during the war. These products were for the most part exceedingly complex in chemical composition but were mainly sulfonated derivatives of phenol and/or aromatic hydrocarbon-formaldehyde condensates, sometimes with the addition of sulphite cellulose liquor to the reactants. Process data is provided for the more complex and important syntans, together with an outline of the composition of simpler or less important products, including products with the names "Tannigan", "Gerbstoff" and "Ferrigan." Some information on the properties of these products is also given. Fat substitutes for the leather industry and agents for

impregnating and waterproofing leather were also made by the I. G. and the composition and manufacture of these are described, including the series "Derminol." Also mentioned are the impregnating and waterproofing series of "Densodrin." Production figures for many of these products are provided. The appendix includes diagram and description of the handling of sulphite-cellulose liquor. (W. Baird, PB 25646; n.d.; 36 p.; M. $1; P. $3.)

Acrylic Esters, Synthesis from Acetylene and Nickel Carbonyl—This report, together with its appendix and flowsheets, covers the synthesis of ethyl acrylate from acetylene and nickel carbonyl and the regeneration of the nickel carbonyl. (J. F. C. Gartshore and J. D. Rose, PB 25648; n.d.; 10 p.; M. $1; P. $1.)

Method to Produce Hydrogen Peroxide (H_2O_2)—This is a translation of a discussion by Dr. Harant on the production of H_2O_2. The discussion covers many of the methods and possible methods in Germany and each process is covered in some detail. The methods discussed are: (1) Barium peroxide and acid; (2) autoxidation of organic compounds; (3) persulphuric acid (Weissenstein process); (4) potassium persulphate (Pretzsch process); (5) ammonium persulphate (Riedel-Loewenstein process); (6) cathod reduction (Berl process); (7) Burning H_2 in O_2 or vice versa; (8) combination of H_2 and O_2 by silent electric discharge. (Dr. Harant, PB 25034; Nov. 1945; 20 p.; M. 50c; P. $2.)

German Techniques for Handling Acetylene in Chemical Operations—The purpose of this report is to present the advances made in recent years by the Germans or, more particularly, I. G. Farbenindustrie in the technique of handling acetylene in chemical operations. This includes the research work done to establish the conditions under which acetylene undergoes explosive decomposition, how these data were used to design plants and set up operating conditions, and subsequent experience in these plants. Most of the processes described have been discussed in other reports so that they are considered primarily from the point of view of acetylene handling techniques. Some of the older and better known processes have not been included. In the early history of acetylene production, many accidents occurred until proper techniques of compressing and storing the material were developed. It can be compressed in slow-moving reciprocating compressors by stages with proper intercooling up to 15-20 atm. The storage cylinders are filled with a porous material, for example kieselguhr, and the acetylene is absorbed in acetone which is also added to the cylinder. Small lines are employed for the most part. Most of the present technique has been developed on a rule of thumb basis over a period of years, and the knowledge so accumulated has been of limited assistance to the chemist or chemical engineer desiring to use acetylene as a raw material under wholly different conditions. Work on acetylene chemistry was intensified just prior to, and during the war. Many of the processes developed required the use of acetylene under conditions not heretofore considred possible for safety reasons.

Added to this report are individual reports of the significant work investigated by the foremost German researchers on acetylene chemistry, photographs, graphs, tables and schematic flow charts (some of which have been translated and reproduced in better form) and the actual process descriptions of processes as carried out at Huls. (N. A. Copeland and M. A. Youker, PB 20078; Jan. 1946; 235 p.; M. $2.50; P. $16.)

Synthesis of Acetone—The information in this report was obtained during an interrogation of Dr. Sachsee of I. G. Farbenindustrie

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I HAD WRITTEN:

Mr. D. M. Whitney, President
John Doe Plywood Company
New York, New York

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Sincerely,
J. T. Bailey
J. T. Bailey
Superintendent

HE HAD ANSWERED:

Mr. J. T. Bailey, Superintendent,
Plant 3
John Doe Plywood Company
Portland, Oregon

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Don't "Dear Chief" me. Cut downtime and rejects - or else! I hold you responsible for production and product quality. Have you never heard of specification resins?

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D. M. Whitney
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PHOTO ABOVE *shows 50 foot long plywood sheet fabricated by Washington Veneer Company, Olympia, Wash. Used in building boats and houses.*

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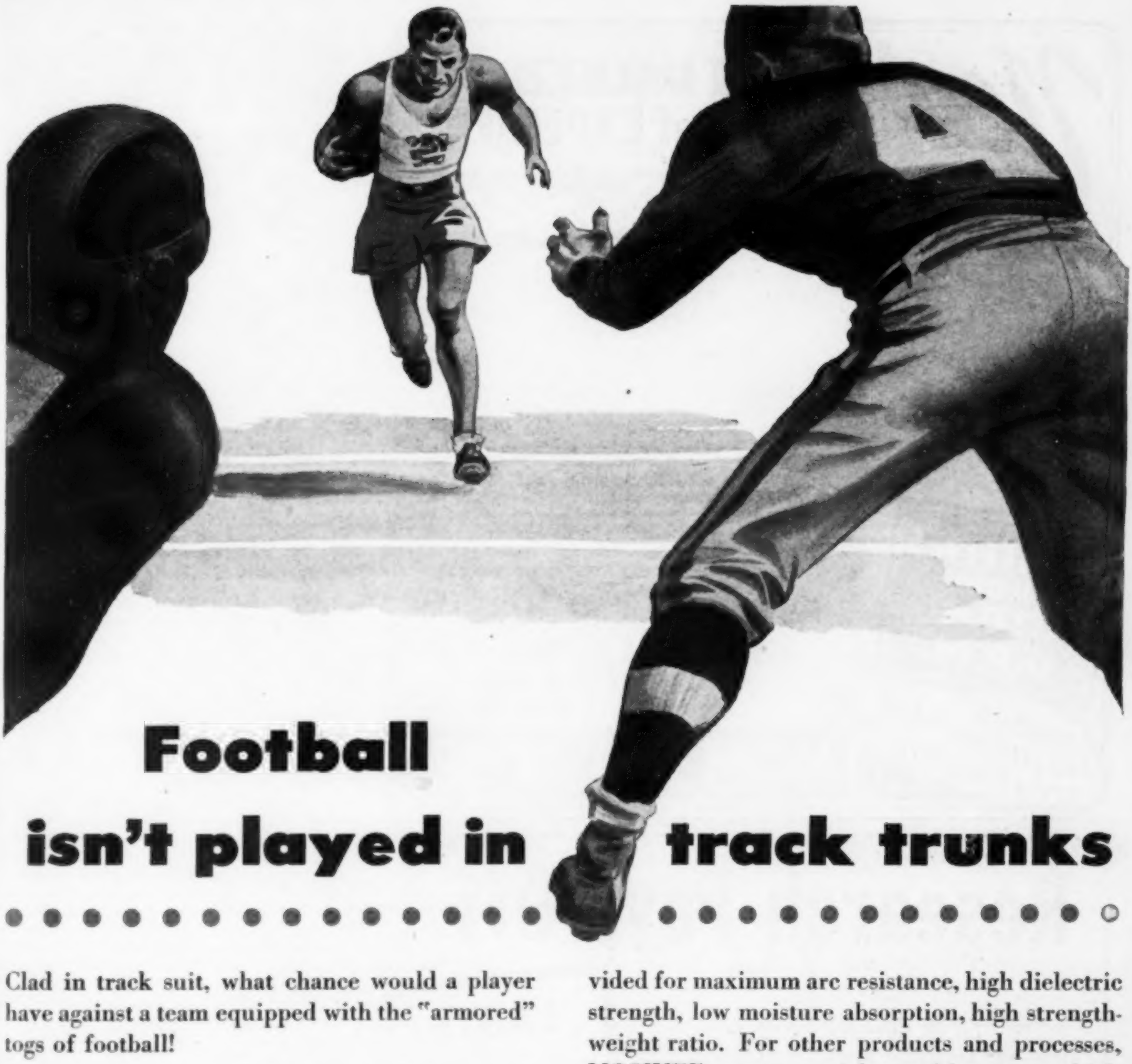
plant at Ludwigshafen, May 28, 1945. The production of acetone at Ludwigshafen was 400 tons per month and the chemistry involved is a novel process. Raw materials are acetylene and water. These are passed in vapor phase over a catalyst of pure zinc oxide. Yields and efficiencies to acetone of 80 to 90 percent of the theoretical are claimed for the process. Byproducts of higher ketones and acetaldehyde are formed, which, if recovered, would raise the efficiency of the consumed acetylene. The method of operation does not attempt recovery of byproducts. (F. H. Roberts, PB 23747; Jun. 1945; 3 p.; M. 50c; P. $1.)

Propargyl Alcohol; Dehydration and Oxidation to Hexadinediol—Aqueous propargyl alcohol recovered from the butinediol plant can be dehydrated by azeotropic distillation with 2,5-dimethyltetrahydrofuran. Experiments also in progress at Ludwigshafen indicated that benzene could be used in place of dimethyltetrahydrofuran. Air oxidation of propargyl alcohol in the presence of ammonium chloride-cuprous chloride catalysts gives excellent yields of hexadiinediol. Flowsheets for the dehydration process and the subsequent oxidation process are given. (J. D. Rose, PB 27124; Nov. 1945; 6 p.; M. $1; P. $1.)

Germany—Fats, Oils and Oilseeds, Holtz und Willemsen GmbH Oelfabriken—This concern operates a crude oil mill, a refinery, hardening plant and margarine factory in Uerdingen/Rhine. The processing in the press mill, in the refinery, in the fatty acid stills and in the margarine plant is described. The refinery contained a unique plant for the distillation of fatty acids from acidulated soap stock and for distillation of high free fatty acid oil prior to refining. The margarine is made according to the somewhat standardized formula of 60 percent hardened rapeseed oil, 40 percent liquid oil which is emulsified in the ratio of 80 percent fat to 20 percent water with addition of salt, carotene and potato meal. No diacetyl or glucose is added. (W. H. Goss and K. S. Markley, PB 25675; Sep. 1945; 6 p.; M. $1; P. $1.)

The Production of Synthetic Fuels by the Hydrogenation of Solid and Liquid Carbonaceous Materials—This report describes the principal methods of producing synthetic fuels by high pressure hydrogenation of coal and tar, as practiced in Germany. The various techniques of operation, designs of equipment, and characteristics of the products are described, and whenever possible, the relative merits and best uses of the different items are discussed. Important economic features of the industry are analyzed so that there is a technical basis for evaluation of the various phases in the light of existing local conditions. The data in this report were obtained either by interrogation of personnel, examination of documents collected from various plants, or by visual observation. Among the processes described are the TTH, "Tief-Temperatur-Hydrierung," or low temperature hydrogenation, and the Pott-Broche process. Appendix A contains tables among them being a table of German coals used for hydrogenation, the "brown" coal being used at Leuna and Wesseling and bituminous coal at Gelsenberg and Politz, and another table giving the summary of operation data for sump phase hydrogenation. Appendix C gives preparations for 5058 catalyst, and Welheim gas phase catalyst No. K 536. (John H. Howell and Roy M. Crawford, PB 27701; Aug. 1945; 121 p.; M. $3; P. $9.)

Production of Beryllium, "Degussa"—A detailed account of the method for producing metallic beryllium as practiced at the Deutsche Gold and Silber Scheide Anstalt plant at Frankfurt. The process is carried out essentially in two phases: first, the preparation of pure



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anhydrous beryllium chloride using the mineral beryl as the ore; and second, the electrolytic production of beryllium, which is about 99 percent pure. (W. B. C. Perrycoste, PB 25668; Nov. 1945; 12 p.; M. $1; P. $1.)

Anti-Oxidant 4010—This anti-oxidant was especially developed for the protection of tires, conveyor belts, and certain cable jackets against fatigue cracks. It does not provide protection against aging through sun-exposure but may be mixed with paraffin and ozokerite. The claim is made that this product is superior to all others including American products based on phenylbetanaphthylamine and diphenyl-p-phenylenediamine. Product 4010 replaces in whole or in part the use of phenylalphanaphthylamine and phenylbetanaphthylamine. The results of testing are given in tabular form. In German. (I. G. Farbenindustrie, PB 17640; Mar. 1939; 9 p.; M. 50c; P. $1.)

The Development of New Dyes and Color Application Processes in Germany and Italy during World War II—This account surveys the German (I. G. Farbenindustrie) and Italian (Montecatini) dye laboratories to determine the new dyes and intermediates and new color applications developed during the war years, with particular attention to developments adaptable to the production of military products. Although research in Germany and Italy was at a low ebb during the war, the investigators report over one hundred new dyes. There is a general discussion of dyestuff developments in the two countries, and a total of 87 appendixes each giving individual specifications for new dyes and color applications. For parts 1 and 2, see PB 31002 and 31003 respectively. (M. A. Dahlen, PB 31004; Oct. 1945; 462 p.; M. $10; P. $31.)

Manufacture and Use of Some German Synthetic Adhesives and Raw Materials—This is a report on German synthetic adhesives. A number of firms were investigated and their manufacturing methods described. Products discussed are: (1) P600 cold setting glue, made by reacting phenol, 30 percent formalin, and caustic soda; (2) "Pressal," fundamentally 30 percent melamine formaldehyde resin and 70 percent starch; (3) "Polystal UII," which is a 50 or 70 percent solution of "Desmodur TH" in ethylacetate; (4) "Desmodur T," which is a mixture of 216 and 214 diisocyanate toluene; (5) "Desmodur TH," which is produced by reacting "Desmodur T" with trimethylolpropane and butanediol; (6) various "Desmophens," made by reacting a polyhydric alcohol with adipic and alone or with phthalic acid; (7) "Maltopren," made by mixing "Desmophen S8," "Desmophen 800," and carbon black; (8) Kaurit, made by reacting 30 percent formalin with urea; (9) "Iporka," made by reacting urea, hexantreal, and formalin; flowsheets of some of the processes are also given. (N. A. De Bruyne, PB 27072; Jan. 1946; 67 p.; M. $2; P. $5.)

Cellulose Acetate Manufacture at Schering A. G., Berlin—The production of "Triacetate-Folie" is described. This is produced only by the Schering A. G. and is a special cellulose acetate film, used for cable wrapping, reported to be outstanding because of its unusual heat resistance. Cellulose (cotton linters or alhpa cellulose from wood pulp) is treated in a glacial acetic acid bath for 5 hr. The acid is then drained. A special charging mixture is then used consisting of 40 parts acetic anhydride, 20 parts H_2SO_4, 40 parts benzene and 0.5 percent $HClO_4$, based on weight of cellulose. The cellulose is still in the wool form and the benzene is important in preventing solution as the acetylation process progresses. This is called the key to the whole process. Maximum theoretical possible acetylation of 62.5 percent is obtained, which the Schering

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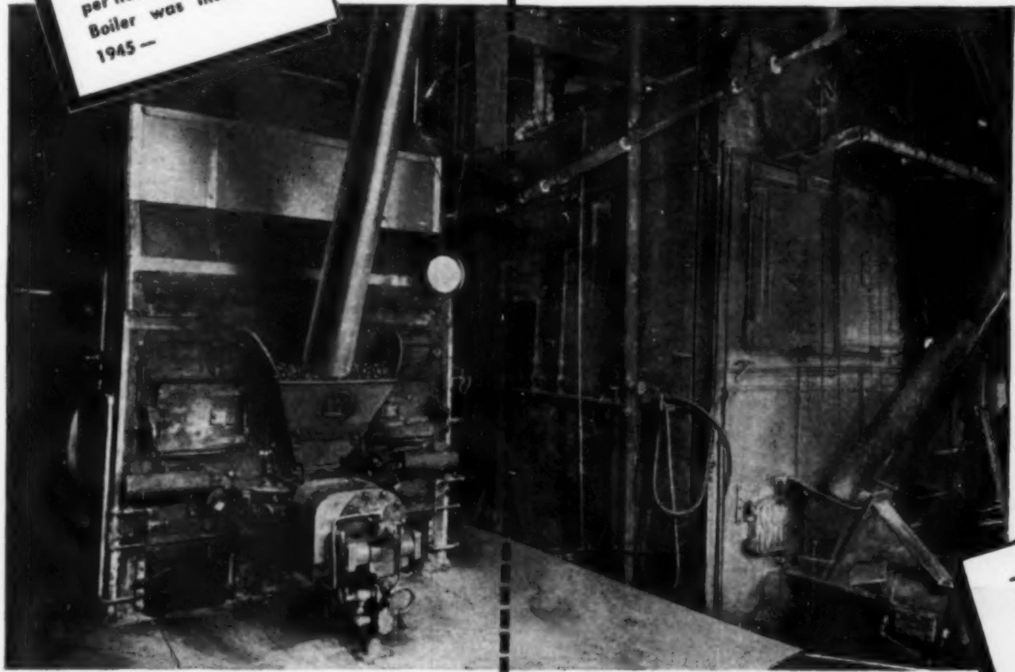

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officials claim is responsible for the excellent electrical properties. Complete removal of the catalyst ($HClO_4$) is effected by keeping the acetate in the wool form, this resulting in markedly improved heat resistance. It is also claimed that the dye used for coloring (Ciba Blue 2R) has a definite stabilizing effect. A diagram of the acetylating equipment is included. Also included is a report, in German, of the process for the production of the cellulose triacetate, by Dr. Hinz, and a sales booklet also in German on its properties and uses. (J. Frederick Myers, PB 25663; Jan. 1946; 14 p.; M. $1; P. $1.)

Production of Aluminum Sulphate Giulini—The report deals with the Gebruder Grulini plant in Mundenheim, Ludwigshafen. This plant was the principal producer of aluminum sulphate in Germany. The plant and operation is described briefly together with a summary of the products made. An analysis of the various products is included. The aluminum was produced in the following strengths 14-15 percent, 17-18 percent, 22-23 percent, and an ersatz sulphate of 9-10 percent. (Horn Freeman, PB 23809; Nov. 1945; 5 p.; M. 50c.; P. $1.)

Use of Monochlorabromomethane by the German Navy and Air Force as a Fire Extinguishing Agent—This report includes a discussion of the chemical properties of monochlorobromomethane and its use as a fire extinguishing agent. Monochlorobromomethane was developed and tested in 1939-40 by the I. G. Farbenindustrie A. G. As prepared commercially, it was commonly known as "C-B." This material was submitted to the German Army, Navy and Air Forces as an improved gas fire extinguishing agent. An extensive investigation had been carried out by the German Navy to develop a substitute for methyl bromide and mixtures of methyl bromide, used aboard naval vessels in fixed gas fire extinguishing systems. Extensive tests to determine the toxicity of "C-B" were conducted in 1940-41 by the Reich Public Health Office at the request of the German Navy. Based on actual fire tests and toxicity reports, the Oberkommando der Kriegsmarine in August 1941 approved "C-B" as the only gas fire extinguishing agent to be used on German naval vessels. In 1942, Junkers/Dessau undertook a research project to develop for the Luftwaffe a light, reliable extinguishing system to control fires in aircraft caused by incendiary shells or ruptured gasoline fuel lines. Tests established that "C-B" discharged by carbon dioxide gas pressure was the most efficient fire extinguishing agent available for this purpose. This mixture—65 percent "C-B" and 35 percent CO_2—was called "Dachlaurin" or "D-L." The Luftwaffe in March 1945 approved a fire protection system for military aircraft using "C-B" as the fire extinguishing agent. New facilities to manufacture and bottle "C-B" were never fully completed before the end of the war. Graphs, diagrams and photographs. (Emmett A. Scanlan and E. Benner Hitchcock, PB 22808; Sep. 1945; 48 p.; M. 50c; P. $4.)

The Synthesis of Hydrocarbons and Chemicals from CO and H_2—This report describes the commercial application and development in Germany of the synthesis of hydrocarbons and chemicals from CO and H_2 during the war. The development took place along seven main lines. First was the Fischer-Tropsch (FT) process. By this method were produced special chemicals and chemical raw materials. In addition, there could be made poor quality gasoline, diesel oils, and intermediates for the production of special lube oils and deturgents. The second development was the "Synol" process. By this process were produced mainly higher alcohols. These alcohols were almost exclusively straight main terminal alcohols

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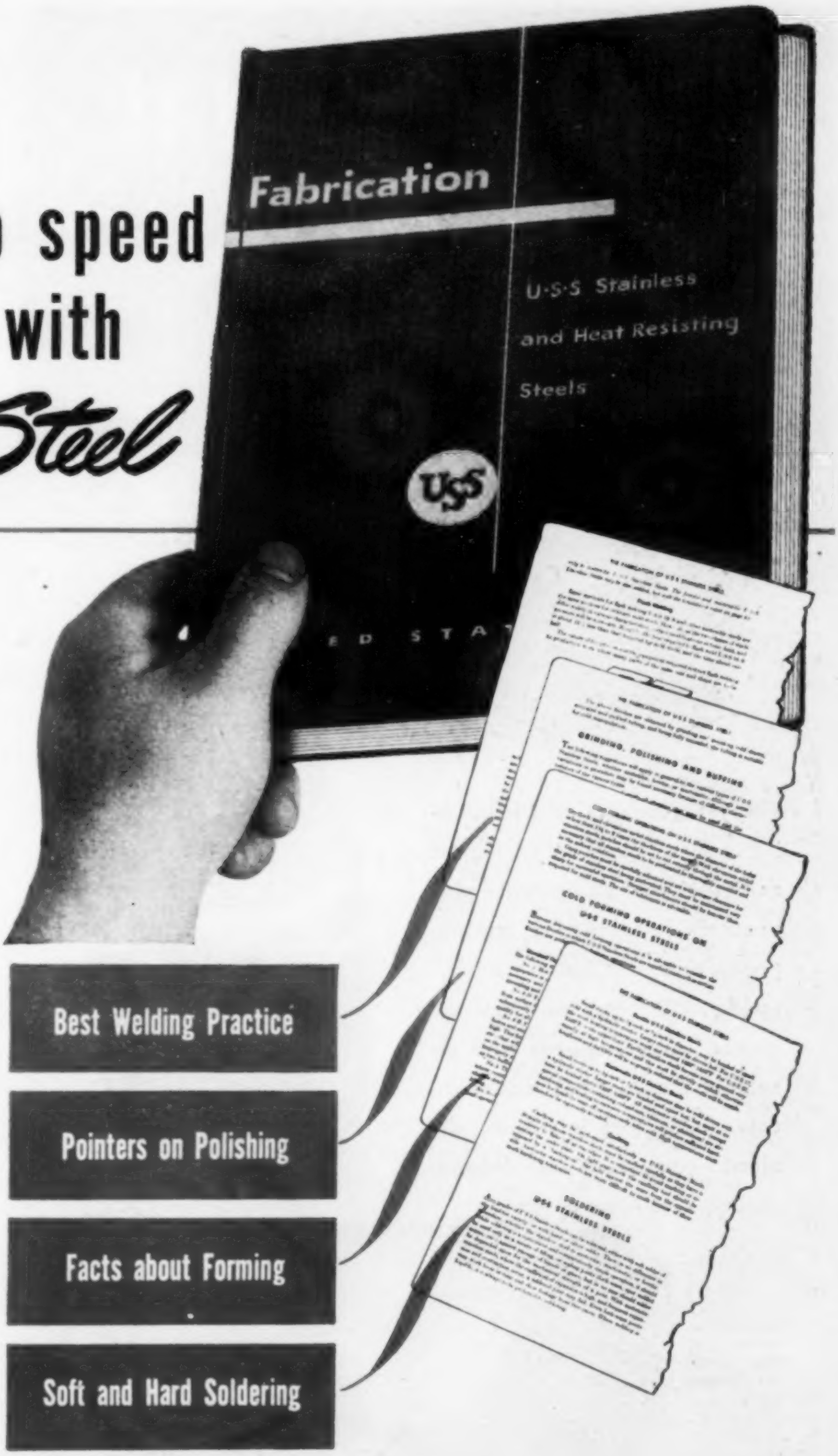

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with a carbon content up to $C_{[illegible]}$. In addition olefines and esters were also produced. The third development was the synthesis of high melting point waxes. This work was done at the Kaiser Welhelm Institute and was only done on a laboratory scale. The products of this synthesis were wide mixtures of high boiling waxes with molecular weights as high as 10,000. The fourth development was the "isosynthesis" worked out on a laboratory scale at the Kaiser Wilhelm Institute. By this method may be produced mostly low boiling isoparaffins, isobutane being the largest individual component. The fifth development was the isobutanol synthesis. The sixth development was a new synthesis of methanol which may be carried out at 30 atm. This work was done on a laboratory scale and resulted in the assembly of a pilot plant. The seventh development was the OXO-synthesis. By this method higher boiling alcohols are prepared by reacting olefines with CO and H_2 over cobalt. These seven processes are of considerable importance since a wide range of products and many intermediary products may be produced which may be used as fuels, lubricants, plastics, in lacquers, and detergents. This report discusses each process in detail as to cost, products, catalysts and gives considerable information as to the production of each of the plants in Germany. (E. H. Reichl, PB 22841; n.d.; 30 p.; M. 50c; P. $2.)

Pentaerythritol: Derivatives and Byproducts—The folder contains business and technical correspondence on various compounds that can easily be obtained in the manufacture of pentaerythritol: (1) trimethylolnitromethane (nitroisobutylglycerol), which could be an important substitute for glycerol in the manufacture of explosives, especially those for civilian use; (2) tetraaminotetramethylmethane disulphate, which could also be used for explosives; (3) the so-called penta-byproducts; (4) pentaerythritol esters, which were tested for use as lubricants, especially those for weapons; and (5) pentaerythritol tetraacetate which is of interest as a carbon carrier. In German. (I. G. Farbenindustrie, PB 17589; Oct. 1940-Aug. 1944; 94 p.; M. $1; P. $7.)

The Production of Monomeric Vinyl Acetate in Germany—Monomeric vinyl acetate was produced in Germany by the vapor phase reaction of acetylene and acetic acid in the presence of zinc acetate catalyst at 170 to 200 deg. C. The catalyst was supported on activated carbon and had a maximum life of 800 tons of vinyl acetate per 2.2 tons of catalyst, or four months at the rated capacity of 200 tons per month. The reactor was a tube and shell vessel with 50-mm. tubes 3.5 m. long in which the yield per pass was 32 percent. Development work indicated that 35 mm. tubes would effect higher yields. Efficiencies were reportedly very high with only traces of acetaldehyde formed. (J. W. Biddle, PB 27700; Aug. 1945; 42 p.; M. $1; P. $3.)

Rohm und Haas, O. G., Darmstadt—The Rohm and Haas plant is one of the major producers of cast methyl methacrylate sold under the name of Plexiglas. Plexiglas was made by the customary oven process. However, the water bath process had been worked out and a plant designed and erected. This process is entirely different from British and American processes The water bath polymerization is covered in some detail. In addition the manufacture of several other forms of methyl methacrylate are described which are used as injection molding powders, compression molding powders, and dental powders. An appendix includes a translation of the work by Dr. Trommsdorf on block polymerization which is considered of great value. (W. Hunter and H. C. Raine, PB 23816; Sep. 1945; 43 p.; M. 50¢; P. $3.)

CORROSION FORUM

EDMOND C. FETTER, Assistant Editor

MODERN MATERIALS • MODERN METALS
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Acetic Acid vs. Materials of Chemical Plant Construction—Part I

This is Part I of a symposium in which manufacturers evaluate their products for acetic acid service. Part II will be published next month.

CARBON, GRAPHITE, KARBATE

E. S. MALKIN
National Carbon Co., Inc.
Cleveland, Ohio

CARBON, graphite and certain grades of Karbate impervious carbon and graphite materials have been found satisfactory and chemically resistant by laboratory tests and commercial applications to all concentrations of acetic acid at temperatures up to the atmospheric boiling point. Some of the services were a combination of acetic acid with hydrobromic, hydrochloric, and sulphuric acids, chlorinated organics, and other compounds made from acetic acid which resulted in corrosive conditions decidedly more severe than from acetic acid alone. The grade of Karbate materials recommended for use depends on the temperature conditions and the impurities.

Porous carbon has been used successfully as a diffuser medium for mixtures of steam, formic, and acetic acids in agers in the textile industry. The pipe and fitting connections were all Karbate products. No corrosion or breakage from thermal shock has occurred in over one year of service.

Karbate graphite base products have been used in various industrial acetic acid processes as heat transfer and conveying equipment, such as plate and bayonet tank heaters, shell and tube evaporators and condensers, centrifugal pumps, globe valves, and pipe and fittings. The actual operating conditions for this equipment have not been made available by the users. However, it is known that acetic acid and combinations with other chemicals are present, and the equipment has been operated without any noticeable corrosion and with complete satisfaction for several years.

Laboratory tests of Karbate materials in glacial and other concentrations of acetic acid at the atmospheric boiling points showed no discoloration of the acid and no change in physical appearance of the material.

In the manufacture of equipment, the individual Karbate parts, such as tubes and tube sheets, are cemented together with impervious, synthetic resin cements similar in strength, durability and chemical inertness to the Karbate products. "National" No. 14 cement has been employed successfully in all Karbate equipment in acetic acid applications. Laboratory test joints made with No. 14 cement showed from none at all to small decreases in strength after several months exposure to various concentrations and temperatures of acetic acid. National No. 8 cement is slowly attacked by acetic acid and is not recommended for these applications.

ALUMINUM ALLOYS

ELLIS D. VERINK, JR.
Aluminum Co. of America
New Kensington, Pa.

FOR MANY years the mutual compatibility of aluminum and acetic acid has been recognized. Aluminum equipment has long been in use, not only for the production of acetic acid and acetic anhydride, but for the production of many products in whose manufacture acetic acid is employed.

For example, in the manufacture of

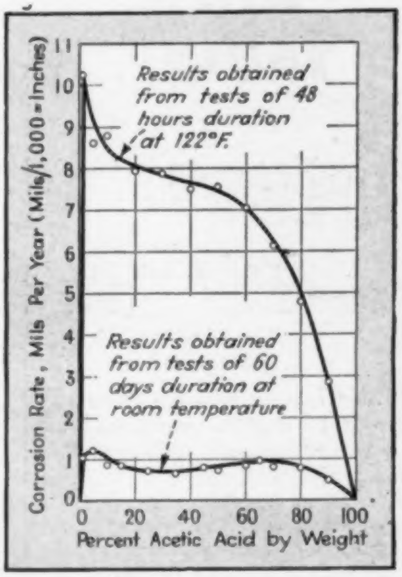


Fig. 1—Curves showing rate of attack of acetic acid on aluminum

Aluminum tanks of welded construction for storage of acetic acid

cellulose acetate, aluminum is used for storage tanks, acetylators, precipitators and centrifugal extractors. Of particular importance in this field is the fact that acetic acid can be handled without danger of discoloration. Therefore, "water whiteness" of acetic acid and products made from acetic acid is assured by use of aluminum equipment.

The rate of attack of aluminum by acetic acid is indicated in Fig. 1. It will be noted that at room temperature the attack is of the order of 1 mil per year regardless of concentration. As the temperature is increased, the rate of attack is substantially increased; however, even at boiling temperatures, attack by glacial ace-

Table I—Results of Tests With 2S Aluminum Immersed in Glacial Acetic Acid at Various Temperatures; Duration of Tests—48 Hours

Temperature	Average Mils Penetration Per Year	Remarks
77° F.	0.45	Specimens dulled and irridescently stained.
125° F	1.6	Immersed areas stained and dulled, portion in vapors darkened.
160° F.	4.7	Immersed areas stained and dulled, portion in vapors darkened.
Boiling	5.3	Immersed areas had dull white appearance, portion in vapor non-uniformly stained.

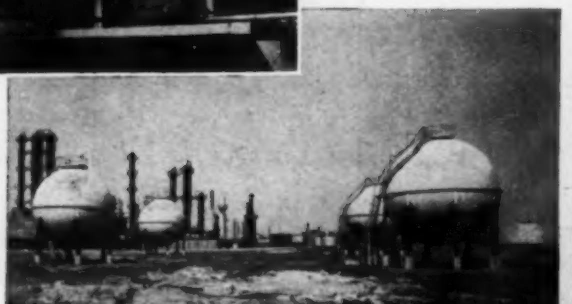
Size of specimens was 3 in. x ¾ in. x 0.064 in., exposed area 2.775 sq. in.

Table II—Elements in Aluminum Alloys

Alloy Designation Wrought Alloys	Cu.	Si.	Mn.	Mg.	Cr.
	Percent Alloying Elements				
2S	....	...	...	....	....
3S	....	...	1.2	....	....
52S	....	...	...	2.5	0.25
61S	0.25	0.6	...	1.0	.25
Cast Alloys					
43	....	5.0	...	....	....
B214	....	1.8	...	3.8	....
356	....	7.0	...	0.3	....
406	....	...	2.0	....	....

Table III—Typical Mechanical Properties of Aluminum Alloys

Alloy and Temper	Yield Strength, lb. per sq. in.	Ultimate Tensile Strength, lb. per sq. in.	Elong. Percent—2 in.		Brinell	Shear Strength, lb. per sq. in.	Endurance Limit lb. per sq. in.
			Sheet	Round Rod			
2S-O	5,000	13,000	35	45	23	9,500	5,000
2S-1/2H	14,000	17,000	9	20	32	11,000	7,000
2S-H	21,000	24,000	5	15	44	13,000	8,500
3S-O	6,000	16,000	30	40	28	11,000	7,000
3S-1/2H	18,000	21,000	8	16	40	14,000	9,000
3S-H	25,000	29,000	4	10	55	16,000	10,000
52S-O	14,000	29,000	25	30	45	18,000	17,000
52S-1/2H	29,000	37,000	10	14	67	21,000	18,000
52S-H	36,000	41,000	7	8	85	24,000	19,000
61S-W	21,000	35,000	22	25	65	24,000	13,500
61S-T	40,000	45,000	12	17	95	30,000	13,500
43	9,000	19,000	....	6.0	40	14,000	6,500
B214	13,000	20,000	....	2.0	50	17,000	......
356-T6	24,000	33,000	....	4.0	70	27,000	8,000
406	9,000	19,000	....	12.0	35	14,000	5,500



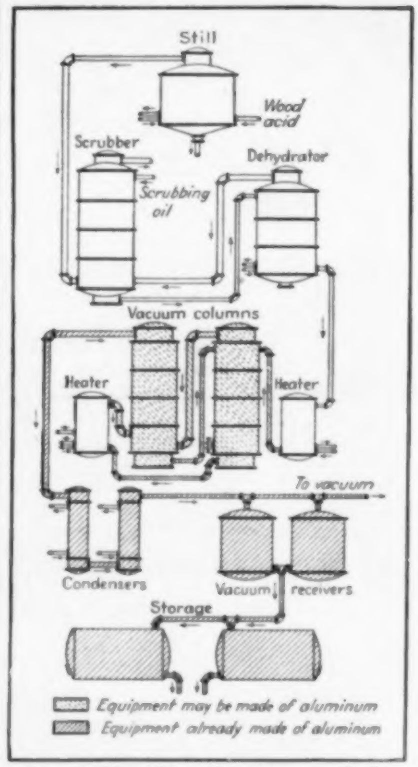


Fig. 1—Flowsheet showing use of aluminum equipment in manufacture of acetic acid from wood

tic acid is of a very low order. Table I shows the effect of increasing temperature on the rate of attack on 2S aluminum by glacial acetic acid.

The data given in Table I were obtained with commercially pure aluminum; however, the alloys listed in Table II should exhibit comparable resistance to acetic acid. These alloys are the most corrosion resisting aluminum alloys. Table III lists some typical mechanical properties.

Fig. 2 is a flow chart for the manufacture of acetic acid by the destructive distillation of wood, showing diagramatically the pieces of equipment which have been successfully made of aluminum, as well as those which experimental data and installations indicate could be successfully made of aluminum.

The alloys which should be used for each of the elements of the system follow: Storage tanks—2S, 3S, 52S, 61S; stills—3S, 52S, 51S; condensers—3S, 52S, 61S; piping —2S, 3S, 61S; valves and fittings—43, B214 alloy; manholes, etc.—356, 406 alloy.

DURIMET AND CHLORIMET

W. D. STALEY
The Duriron Co., Inc.
New York, N. Y.

DURIMET T (22 Ni, 19 Cr, 3 Mo, 1 Cu, 1 Si, 0.07 max C.) and Durimet 20 (29 Ni, 19 Cr, 3 Mo, 4 Cu, 1 Si, 0.07 max. C.) possess satisfactory resistance to both crude and pure acetic acid in all concentrations at temperatures normally encountered. This is in contrast to stainless steels of lower alloy content which often show border line passivity in acetic acid service, particularly at higher concentrations

and temperatures. In addition to being satisfactory over the entire range of concentration, Durimet T and Durimet 20 show good resistance under nonaerated and reducing conditions.

Laboratory test data indicates negligible rates of corrosion as shown by the results in the accompanying table:

Corrosion Rate on Durimet T in Boiling Acetic Acid

Percent Acid	Mils Penetration Per Year
10	0.08
50	0.20
75	0.08
Glacial	0.10

Typical of laboratory tests on Durimet 20 is a test in an aerated solution of 70 percent acetic acid, 16 percent salicylic acid and 14 percent water at normal temperature. The greatest loss was equivalent to 0.6 mils penetration per year.

The limiting temperature for Durimet T and Durimet 20 in acetic acid is not known definitely but these alloys have been found unsuitable for handling strong acetic acid at temperatures over 300 deg. F. with pressures above 150 lb. per sq.in.

Numerous cases may be cited of results under actual service conditions and this information is generally more dependable than laboratory data for selecting the most suitable alloy for the job. Reference will be made to installations that include primarily Durimet pumps and valves inasmuch as these Durimet alloys are available only in the cast form, except for limited quantities of Durimet T bar. It is expected that Durimet 20 bar and sheet can be supplied at a later date.

Durimet equipment is giving satisfactory service under the following conditions:

1. Durimet T pumps: 20 percent acetic acid and 3-5 percent sulphuric acid at room temperature.
2. Durimet T pumps: Glacial acetic acid containing less than 0.5 percent each of sulphuric acid and sodium bichromate at 80 deg. F.
3. Durimet T plug valves: 10 percent acetic acid and mercury salts at atmospheric temperature.
4. Durimet 20 valves: Crude acetic acid with some formic acid at 200 deg. F. (Durimet 20 valves in good condition after eight months where valves in stainless compositions of lower alloy content had failed in about three weeks).
5. Durimet T valves, fittings, hose connections and gage glass fittings: Strong vinegar at normal temperatures.

Equipment available in Durimet T and Durimet 20 includes pumps, valves, steam jets, fittings, tank outlets and special items designed for production in stainless steel. Some of these items are more readily available in Durimet 20 than Durimet T because Durimet 20, being somewhat superior to Durimet T for certain applications, has been selected as a "standard" for production reasons.

Chlorimet 3, a nickel-base alloy (62 Ni, 18 Cr, 18 Mo, 3 Fe and 0.07 C) possesses good corrosion resistance to acetic acid and is the preferred high strength alloy for exceptionally severe conditions. Although this alloy possesses good resistance to most acids, particularly under oxidizing con-

ditions, plant and laboratory tests have shown no appreciable attack on Chlorimet 2 in anhydrous acetic acid—organic compound mixtures which are reducing in nature.

Chlorimet 2, a nickel base alloy (62 Ni, 32 Mo, 3 Fe and 0.10C) is not suggested for acetic acid applications because of the excellent corrosion resistance of Chlorimet 3 and the somewhat lower cost of Chlorimet 3.

GLASS LINED STEEL

O. I. CHORMANN
The Pfaudler Co.
Rochester, N. Y.

All concentrations of acetic acid, at room temperature, may be successfully stored in single shell, one-piece, glass lined steel equipment, up to and including a maximum capacity of 8,000 gal. and a maximum internal pressure range of 40 to 80 lb. per sq.in., depending upon steel thickness and type of heads specified.

The normal maximum capacity is 4,500 gal., yet this capacity may be increased to, but not exceeding 8,000 gal., after careful consideration of all the conditions involved. Chemical durability of Pfaudler standard glasses, as applied to a steel base, is excellent towards acetic acid. This is equally true for acetic anhydride.

Table I gives the corrosion rates for various concentrations of acetic acid, at room temperature, for Pfaudler standard glasses that would be specified for this service. Based upon a minimum thickness of the cover coat of glass of 27 mils and a maximum thickness of 36 mils, the estimated life of the glass is excellent.

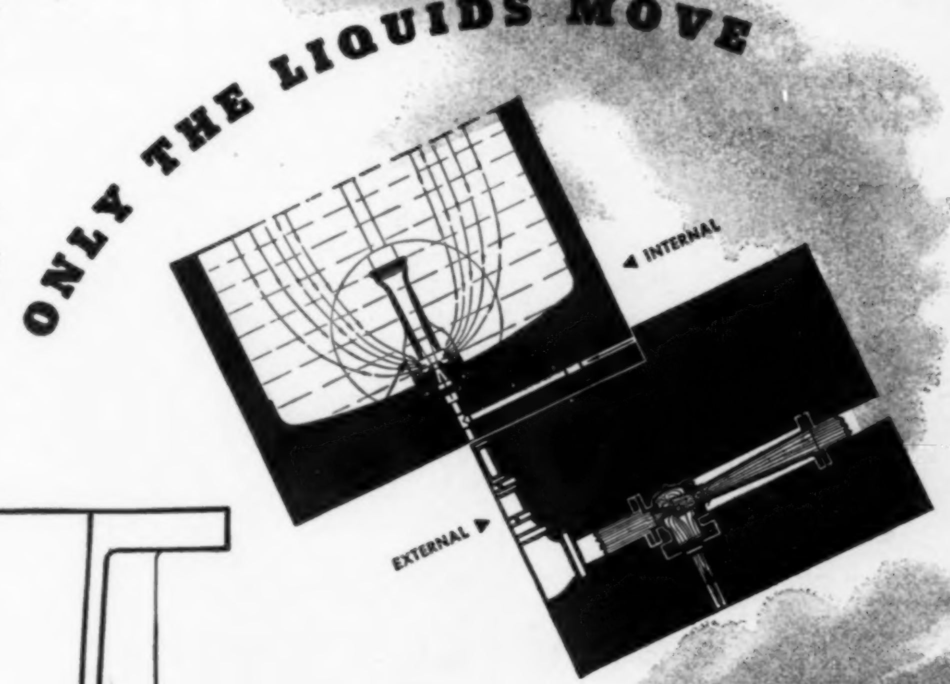
Table I—Corrosion Rate of Pfaudler Standard Glasses in Acetic Acid at Room Temperature

Acid Concentration Percent by Wt.	Number of Glass 27	42	42PF	24
	Mils Penetration Per Year			
2	0.0057	0.0038	0.0080	0.0057
5	0.0156	0.0037	0.0039	0.0019
10	0.0095	0.0020	0.0037	0.0019
20	0.0078	0.0019	0.0019	0.0019
40	0.0078	0.0037	0.0328	0.0058
60	0.0077	0.0092	0.0390	0.0074
80	0.0019	0.0018	0.0020	0.0019
Glacial	0.0036	0.0074	0.0038	0.0058
Acetic anhydride	......	0.0038	0.0019	0.0041

When jacketed glass lined steel equipment is considered for conducting reactions involving acetic acid at elevated temperatures and pressures, some modifications with respect to types of equipment and capacities are necessary.

For reaction units involving elevated temperatures and pressures, there are two standard series of glass lined steel units to select from in order to meet a given set of operating conditions.

The first type of standard glass lined steel reactors cover a capacity range of 5 to 2,000 gal., but owing to the fact that the top head is held in place by clamps, the maximum allowable internal working pressure and the jacket pressure is somewhat less than in the case of the jacketed one-piece, glass lined steel reactors. This standard type reactor, known as the P, S, M, L, LL, XL and XXL series, covers an internal pressure range of 15 to 38 lb. per


ONLY THE LIQUIDS MOVE
INTERNAL
EXTERNAL

sq.in., and a jacket pressure range of 50 to 100 lb. per sq.in.

Another type of standard glass lined steel reactors covers a capacity range of 350 to 2,000 gal. They are of one-piece construction thereby permitting higher internal and jacket pressures. The internal pressure range is from 50 to 125 lb. per sq.in., and the jacket pressure range from 85 to 90 lb. per sq.in.

Test data on the chemical durability of Pfaudler standard glasses towards boiling acetic acid, are shown in Table II. The increase in temperature resulted in a decrease in the corrosion resistance yet the life of the respective glasses is exceptionally good.

Table II—Corrosion Rate of Pfaudler Standard Glasses in Acetic Acid at Boiling Temperature

Acid Concentration Percent by Weight	Number of Glass 42	42PF
	Mils Penetration Per Year	
5	0.2598	0.4595
40	0.0928	0.2401
Glacial	0.0413	0.0836

Taking the highest corrosion rate given in Table II, namely, 0.4595 mils per year for glass No. 42PF, and a minimum cover glass thickness of 27 mils, the life of the glass exceeds fifty years.

The standard types of glass lined steel equipment manufactured for the chemical industry have given satisfactory performance for the chlorination, esterification and sulfonation of acetic acid.

Attention is drawn to the fact that all jacket pressures must be reduced by the amount corresponding to a full vacuum within the inner glass lined steel shell whenever such an operating condition exists.

SILVER

L. C. BURMAN
Baker & Co., Inc.
Newark, N. J.

SILVER is recommended as a material of construction resistant to corrosive attack by acetic acid in all concentrations and at all temperatures. Excess oxygen in the solution has no effect upon the resistance of the silver to such attack. Palladium is equally resistant to attack by acetic acid but is considerably more expensive than silver though palladium-silver alloys are recommended for those situations where mechanical conditions require an alloy tougher than the comparatively soft and ductile silver. A feature of silver in organic operations is that many of the silver organic compounds are colorless and therefore not objectionable should small quantities contaminate the product.

Apart from the use of silver for its corrosion resistance are the superior heat transfer qualities and the ease of fabricating complicated shapes. Coil and tubular condensers and heat exchangers are successfully used against acetic acid corrosion. At pressures beyond which solid silver or silver alloys may not be used economically because of the weight of metal required for mechanical strength, silver clad materials are available and in use. Two types of cladding are in general use. One involves

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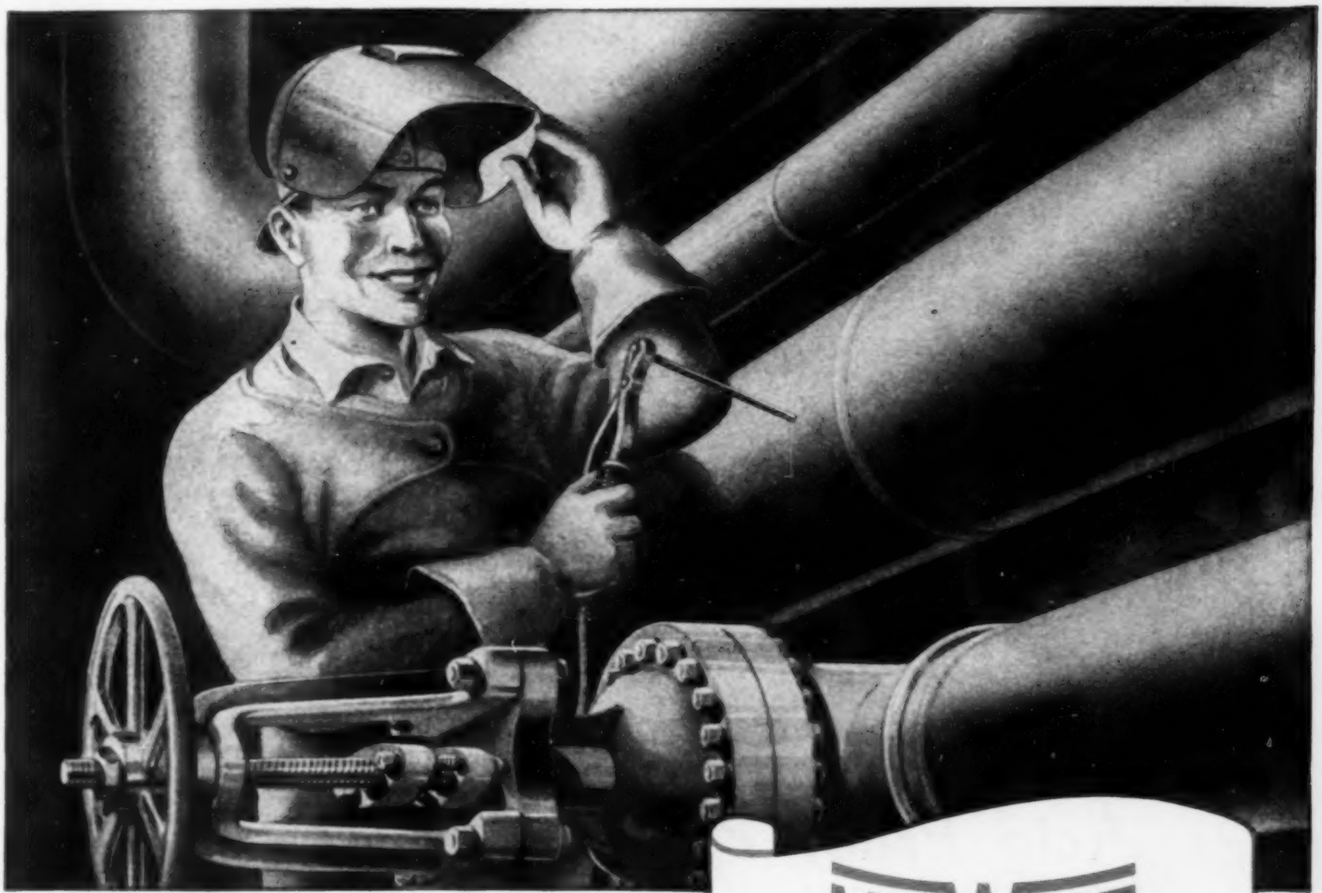

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the use of high pressure and heat for a metal to metal bond between silver and a base metal. The other involves fitting silver or silver alloy shapes to parts or equipment already fabricated or partially fabricated. In this latter case, the silver liner may be expanded into or drawn tightly over heavy walled tubing or pipe. Or a tube sheet and its holes may be lined to receive a bundle of tubes clad inside, outside or on both sides. In general, silver and the silver alloys are readily fabricated into any required shapes for the purpose of protecting base metal chemical equipment.

Techniques have been developed for the joining of silver lined tubing with or without flanges. The same is true for tubing clad on the outside, or inside and outside, except that these are joined without flanges. These techniques involve the use of silver rings inside or outside of the tubing, as required, and silver solders.

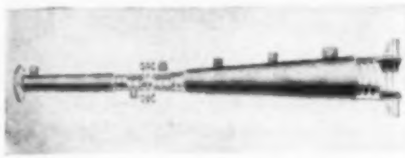
TANTALUM

FREDERICK L. HUNTER
Fansteel Metallurgical Corp.
North Chicago, Ill.

TANTALUM has been found inert to acetic acid or mixtures containing acetic acid at all concentrations or temperatures at which it has been tested or used. At low concentrations and mild temperatures, other materials are sufficiently resistant so that tantalum is recommended only for severe conditions, and for heat transfer surfaces.

Tests up to 175 deg. C. show no attack on tantalum. Above this temperature the effect, if any, is not known. So far as tests and actual service indicate, the degree of concentration, either general or localized, has no apparent effect upon tantalum.

It has been observed in industry that the presence of certain contaminating materials enhances the corrosive effect of acetic acid, but this does not seem to affect tantalum. A tantalum condenser has



Tantalum condensers have been used successfully for six years in hot distillation of crude acetic acid where contaminating materials cause severe corrosive conditions

been in service six years in the distillation of crude acetic acid from wood products under conditions where the acid quickly corroded other condenser materials which had been tried.

Tantalum heaters have been used successfully for heating crude acetic acid for distillation into pure acid. In this case, the use of tantalum in the condenser was not considered necessary.

Because of this peculiar effect of contaminating materials, users are urged to test materials of construction under actual operating conditions, and not rely upon laboratory tests with pure or commercial acid.

FROM THE LOG OF EXPERIENCE

DAN GUTLEBEN, Engineer

JOINTS in tanks and shells of manufacturing apparatus are now usually welded. No attention ever needs to be applied to them. However there are still in use millions of joints made before welding proficiency was achieved and so the maintenance slaves are occasionally annoyed with a cantankerous leak. If welding is applied, the entire joint and every rivet head has to be welded as the strain from the heat opens the joint or loosens the rivet ahead of the electrode, and it may even cause the previously welded joint to crack. Calking also lacks permanency on an old rusty joint especially if there is alternate heating and cooling.

SEAFARING MEN have a device to stop leaks in butt joints that land lubbers can apply with profit. The sketch shows the bottom cone of a 15-ft. water sedimentation tank with butt strapped joints that continued stubbornly to leak even after every rivet had been welded. The old shipyard stunt licked the difficulty. As shown in the sketch a hole was drilled through the outside buttstrap and tapped for the ½ in. SAE threaded nozzle of a screw gun. The gun forced red lead paste behind the butt straps under high pressure and sealed the leaks. We have thus plugged leaks in sugar mixers 25 years ago. In fact the device is so old that it can now be safely re-described under the head of new discoveries.

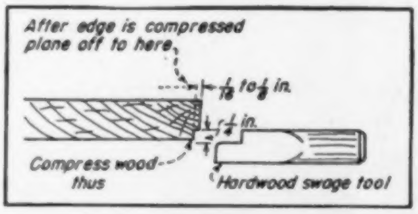
SOME OF THE OLD JOINTS cannot be economically reparated because of the time-consuming dismantling of the circulator drive above as well as the condenser connections. The sugar boiler just cannot spare the pan although he keeps right on kicking about the deficiency of the vacuum. To maintain his happiness, two joints, 30 years old, were made with a copper butt strap riveted on the inside as shown and then packed behind by the aid of the red lead gun referred to above. It required a 36-hr. week-end punishment and 70 lb. of red lead putty but it avoided inconvienience to the customers. This joint may not be permanent as geologists reckon time but none of us will live long enough to disprove it.

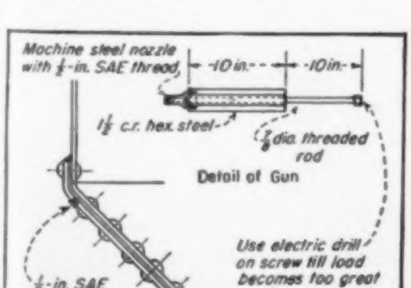
ROW BOATS that old Elisha Mills used to build for his fishing trips were made of clear "cork pine" that was still available in the Michigan lake country in 1900. To secure a tight joint between the longitudinal boards, Elisha compressed the fibers of the edge of the boards by means of a hickory swage about 2 in. wide. Thus he obtained a shiplap cross section with a quarter inch of the board thickness compressed a sixteenth to an eighth of an inch. Then he planed off the edge that was not compressed and assembled the boards into the hull. When the boat hit the water the compressed edges swelled rapidly and made tight joints.

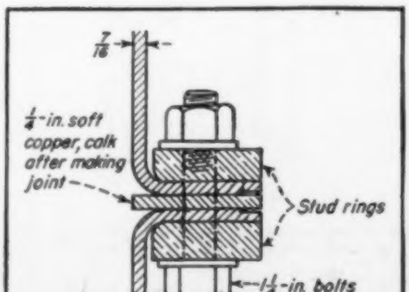
THE OLD BOLTED JOINTS in the shell of copper vacuum pans, designed partly for stiffness, are usually made with red lead paste as the surfaces are not smooth enough for gaskets of rubber or asbestos. In recent years other joint sealing pastes have come into use. But anyhow after 10 years of exposure to boiling out alternately with caustic soda and hydrochloric acid for scale removal, the joints begin to leak. In this case the joint is separated and a ¼-in. soft copper calking strip, covered with thin red lead paste, is inserted. The old ⅞ in. bolt holes are reamed out for 1¼ in. bolts and then the bolts are pulled up with a long-handled wrench till a caliper shows that they are beginning to stretch. The copper strip is then calked on the inside, and forever after protects the red lead from exposure. The same device is used on the juice side of calandria tube sheets; the steam side can be made permanently tight with red lead, but the important thing is to use oversize bolts even though the designer says it's crazy! It is also important to pull up all of the bolts evenly. The last round that stretches the bolt may gain less than an eighth of a turn.

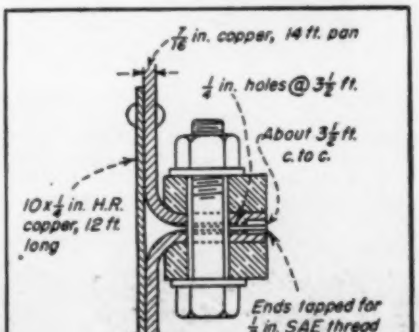
EVERY BEET SUGAR ESTATE has a staff of agriculturists who circulate among the farmer clientele and establish a mentor-disciple relationship. These peregrinating pedagogues furnish the highly specialized technology that beet culture demands plus the latest in farm mechanics and, for good measure, they exude cultural influence. The beet has the unique characteristic that it projects a network of roots into the soil as far as seven feet in depth. After the harvest these supply a ton of humus per acre and leave a honeycomb of channels for aeration, bacterial action and water supply, which improve the soil for rotation with other crops. Beet culture demands superior intelligence, deep plowing and thorough soil preparation but in return it increases the productive capacity of the lands and raises the taxes. Then along comes an exploding city like Los Angeles and demands onions and carrots whose waterlogged quality renders long-

Tank butt joints can be sealed as shown (lower left) in the sketch. Row boat construction gives an idea for use in wooden tanks and containers (upper right). Old bolted joints (below) may be calked with copper strips. Sugar boilers have repaired joints (lower right) by using a butt strap and red lead gun







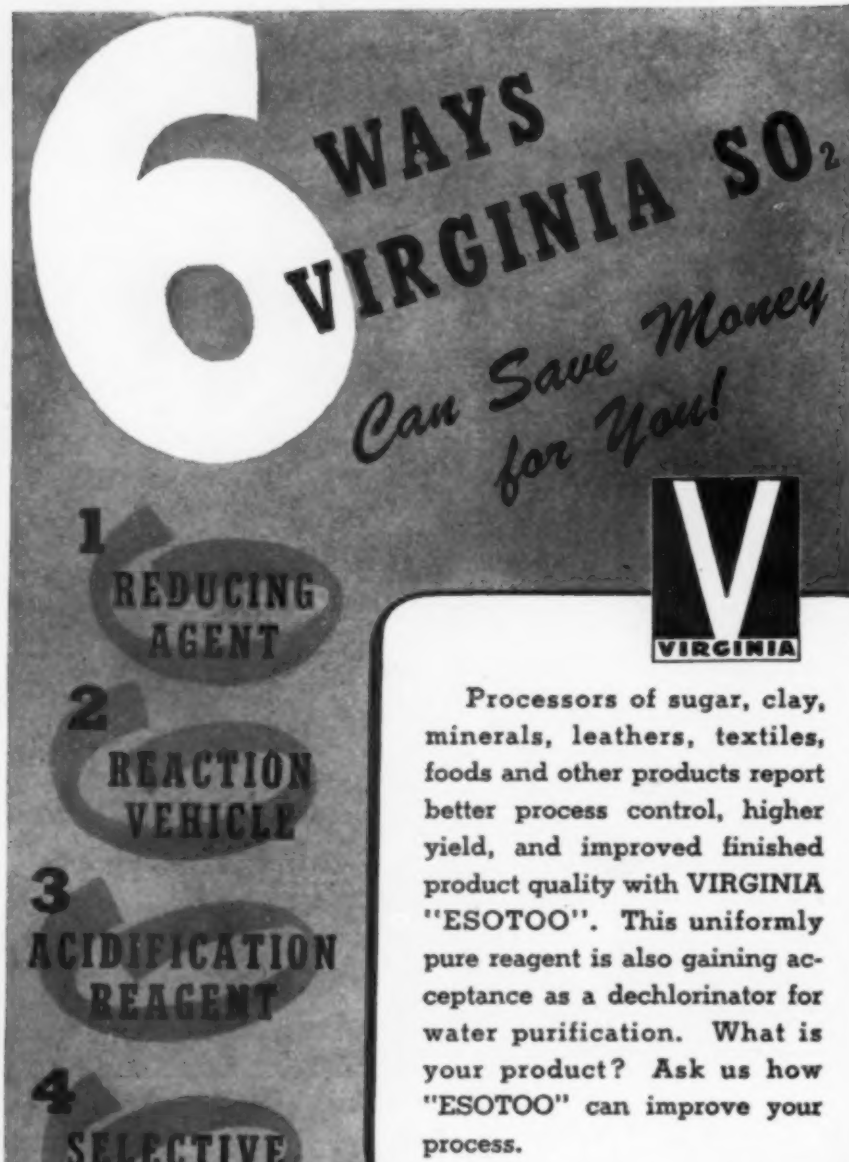


distance transport costly while the concentrated dried extract from the beet is a good traveller. Moreover the garden-plot subdivisions near the cities are not big enough for sugar planting with modern mechanization. Beets require processing in transit to the consumer while the garden produce, being a ready-to-use product, attracts a higher price. Anyhow, the sugar factory, having improved its competitor's position, is driven from the field and moves with its accessory activities of stock feeding to open country.

THE END PRODUCTS from cane and beets after the extraction of sugar were originally dross, refused even at the public dump. Land-baron Hihn magnanimously and for the annual rental of $1 executed a 10-yr. lease for the site of a 50-ton beet sugar factory near the great California resort of Santa Cruz. The factory was built in 1874 at an outlay of $70,000 and produced some sugar and an amount of molasses disproportionately large. After four years the crude little factory defaulted its rental payment and reverted to farmer Hihn. He cast out the machinery to make room for hay but the stubborn, tar-like molasses resisted his efforts at disposal. He lacked knowledge for its preparation for stock feed. His law abiding instinct plus the fact that he did not know how, prevented him from converting the nuisance into "white mule," an activity promoted in recent years by Uncle Sam for the Virgin Islanders. This product provides bread-and-butter for the islanders and headaches for the "nephews."

BEET LEAVES, now highly prized for stock feed, were recommended by a farmer of Lamar, Colo. as long ago as 1903 for use in the manufacture of Pittsburgh Stogies. As reported in the *Planter*, he has made cigars from beet leaves soaked in an infusion of tobacco. "These cigars," he avers, "have a better flavor than many now on the market and are superior in sweetness and delicacy of flavor to any Connecticut cabbage fillers ever made."

BEEF STEAK is a byproduct of beet sugar production. The company farm at the Tracy, Calif., sugar estate, now classed as manufacturing equipment, originally alternated white patches of alkali with salt grass. Not even weeds would grow on this soil. For years the farm was flooded with the sewage from the factory which flushed the alkali through the drainage system and left the plant food in the soil. Now this farm is featured as souvenir postal cards glorifying the beauties of California. The field now produces beets about every third year and rotates with hay and grain. The hay and grain, tempered with cottonseed oilcake, and mixed with exhausted beet pulp and final molasses are fed to steers. The end product from the feed pens and the drainage are returned to the fields. The waste water from the Steffen process is elaborated into the meat extender, mono sodium glutamate, by the aid of which the housewife can convert corn meal mush with a judicious admixture of nuts, celery, onions and tomatoes into a delectable meat loaf. Cowboy Collinson (imported from Texas) is charged with the responsibility



of providing satisfactory working conditions so that the steers can eat, rest, extract contentment out of life and produce beef. Among the comforts, he supplies a scratcher to relieve the itch of stretching hide. This device consists of a discarded beet elevator chain draped over two posts seven feet high with the ends securely anchored in the ground after the manner

of a suspension bridge. By going under or over the catenary or by straddling the inclined anchorage chain, fore or aft, the steer reaches every part of his anatomy and enjoys relief.

AN IMPORTANT BYPRODUCT of the stress and strain of the daily task is humor used on the spot as an antidote for gloom and frayed nerves. It is a mystic thing once dispensed by specialists as a sedative at the courts of harassed kings. The boys extracted it even out of old Doc Portius' Prussian discipline. Doc, also affectionately known as "Raffinose," was the chief of staff at Chino. As star performer he demanded obsequious respect from the subordinates. He graduated from the University of Jena about 1876, taught for two years at the Braunschweig Sugar Institute and then worked in a German sugar house till Oxnard discovered him in '91 and commissioned him to select an operating crew and proceed to Chino, Calif., to make sugar.

He used to bid goodnight with a flourish to publicize his departure, and when everybody had settled down to the enjoyment of freedom from kibitzing, he would suddenly reappear right in the midst of a crap game. Occasionally at low twelve he might slip over in his carpet slippers from his bachelor quarters above the office. Thoughtlessly he switched on the light and thus unwittingly flashed the signal which the official lookout broadcast to warn the craftsmen.

WALTER TURNER, the colored coachman with impaired hearing and a sluggish mentality, used to meet Doc at the Pomona station at 7 p.m. with the old two-seated surrey, the rear seat of which had become loose. The roads were rough and dusty. The old gray mare always started with a jerk and, if Doc ever made any objections, they were lost on Walter's perception. The surrey's rattle soothed Walter's ears and besides he had grown callous to bawling out. One evening when he drew up at the Chino clubhouse he waited for Doc to get out. Sensing no stir in the rear, he looked around and was surprised to observe that both Doc and the seat were gone. He drove back and found Doc undamaged but exhibiting a ruffled temper.

DOC'S OCCASIONAL TRIPS to Los Angeles served the purpose of surcease from toil. He usually met Engineer Baur there and Southern Pacific's chief engineer William Hood for the enjoyment of music or the "Gemütlichkeit" of a Rathskeller. On one occasion he met an important Chino villager making holiday accompanied by

two attractive young women. Doc suggested dinner. He had in mind the German custom while respondents contemplated the American plan. Doc enjoyed the dinner and urged generous selection from the menu or as he expressed it, "Griefen sie hinein ins menschlichen Leben." At the conclusion of the festivities, Doc picked up his check and paid for it, leaving the others to do likewise, all in accordance with the sensible custom of Dutch treat.

UNUSUAL EXPERIENCES in never-ending variety come to the craftsmen. Something happened in one of Tom Lacey's wells at the Santa Ana factory and before anyone knew it, the condensers, leg pipes and sewer were plugged with sand and the water overflowed into the pans and evaporators and flooded out the works. No mechanical damage was suffered but the works lost five hours of production.

THE MOLASSES STORAGE TANK back of the machine shop had a 4-ft. square patch welded on by a wartime welder just in line with the passage through the shop. One Saturday evening when the tank was full this patch grew tired and let go, sending a gusher of 80-Brix molasses through the shop and boiler house. In a few seconds the draft ducts under the boilers were sealed. The fireman had the presence of mind to shut off the fuel gas. The feed pumps chattered to a stop but the hot furnaces maintained combustion for a time with molasses. The engineman saw the avalanche of molasses headed towards his station and tripped the throttle on the engine. The big flywheel was just idling to a stop when the molasses reached the pit.

THE HUNTINGTON BEACH factory was erected by skipper Tony Tovatt. After the close of a Saturday night show he drove home by way of the factory. He roamed about the building in the moonlight to appraise the day's accomplishment and lingered about the well-drilling operation. Here he observed an odor of gas and when he struck a match a tongue of flames leaped up above his head. He grew excited and hastened to the bedside of Boss Sinsheimer to deliver the tremendous news. He urged immediate liquidation of the sugar house and the expenditure of the proceeds plus the balance of the construction account for expansion of their 64-acre property. The boss told tim to go to bed and sleep it off! However ten years later the Holly Sugar Corp. abandoned sugar operations there and developed its underground assets into the highly profitable Holly Oil Co.

A JUSTIFIABLE HOBBY possesses the quality of interest or usefulness beyond the individual hobbyist. Oliver Swan while manager of the Grand Island, Neb., beet sugar factory, pursued the hobby of pheasant production. He grew large flocks and then released them to propagate on the prairies. This developed into a public benefaction. It brought profit to the farmers who sold hunting licenses to tired business men. It also brought to Swan a letter of thanks from the governor of the state.

NAMES IN THE NEWS

J. J. Keville, Jr.

J. R. Ruhoff

E. D. Wingfield

John J. Keville, Jr., has been appointed director of product application of the plastics division of Celanese Corp. of America, where he will head the corps of engineers who evaluate markets for Celanese plastics and study techniques and processes for the fabrication of new products.

Perry A. Martinson has resumed duties with Johns-Manville in Chicago after discharge from military service. Mr. Martinson has returned to his position as chemical engineer in the filler and filtration department.

Ivan Bloch, chief of the Bonneville-Power Administration's division of industrial and resources development, has been loaned to the Department of the Interior as special consultant to Secretary J. A. Krug. In this capacity, Mr. Bloch will prepare a series of reports dealing with the economic growth of the nation, particularly in the West and in Alaska.

Robert Wilson, Harvard University physicist formerly with the Los Alamos, N. M., laboratory of the Manhattan District Project, has been elected chairman of the Federation of American Scientists.

Frederick Whittier has joined the Bickford Research Laboratories at Avon, Conn. Mr. Whittier was formerly engaged in research and other technical work for the Barrett Division of the Allied Chemical & Dye Corp.

R. J. Schrader, formerly head of the chemical engineering department of Tennessee Eastman Corp. at Oak Ridge, has been transferred to the plant at Kingsport, Tenn., where he has been assigned duties in the research division.

R. R. Williams, retired director of chemical research of the Bell Telephone Laboratories, has been announced the recipient of the 1947 Perkin Medal. Presentation will take place in January.

John R. Ruhoff, lately colonel, Corps of Engineers, U. S. Army, has rejoined the staff of Mallinckrodt Chemical Works, St. Louis, as technical director.

W. Burling Tucker, for many years district engineer for the California State Division of Mines, Los Angeles, has been appointed chief of the division with headquarters in San Francisco to fill the vacancy left by the retirement of **Walter W. Bradley.**

Everett B. Evleth has been appointed president of Ray Control Co., Pasadena, a subsidiary of Lane-Wells Co. Mr. Evleth was formerly vice president and general manager of Brown Instrument Co. of Philadelphia.

William H. Milton, former assistant general manager of the chemical department, General Electric Co., is to continue as administrator in the company's operation of the Hanford Engineer Works in eastern Washington. **David H. Lauder**, former general manager of the service engineering division of the company's apparatus department, is works manager.

Edward A. Schraishuhn has been released from service in the Navy and has joined the chemical engineering staff at the University of Pennsylvania. Mr. Schraishuhn is a Pennsylvania graduate.

Harold M. Vessey has joined the chemical engineering group of the technical department at the South Charleston division of Westvaco Chlorine Products Corp. Mr. Vessey before joining Westvaco's staff, was employed by the Pennsylvania Industrial Chemical Corp., while at the same time doing graduate work in chemical engineering at the University of Pennsylvania. Two other additions include **Albert G. Draeger**, who was employed by Victor Chemical Co. before coming to Westvaco, and **Henry C. Watlington** who was with the research group of the Dan River and Riverside Cotton Mills.

E. D. Wingfield has been appointed general manager of Freeport Sulphur Co. Mr. Wingfield has been assistant general manager for about the past two years. He will continue to have offices in New Orleans, headquarters for the company's mines in Texas and Louisiana.

Frederick D. Rossini, chief of the thermochemistry and hydrocarbons section of the National Bureau of Standards, has been elected president of the standing committee of thermochemistry of the International Union of Chemistry.

Nathan E. Van Stone, director of manufacturing operations of the Sherwin-Williams Co., has been appointed vice president and executive director of the special chemical products division.

M. H. Clarke has been appointed to the post of vice president and director of manufacturing of the Dayton Rubber Manufacturing Co. He will direct engineering, production, laboratory, traffic, safety and plant protection activities in all the company's operations.

D. B. Keyes has been elected a member of the board of directors of the American Potash and Chemical Co. Dr. Keyes still retains his membership on the boards of Heyden Chemical Corp. and American Plastics Corp.

Frederick B. Sackett has been appointed manager of the Defender plant of the Du Pont photo products department in Rochester. Mr. Sackett succeeds **L. Dudley Field**, who became the department's adviser on paper products.

Horace D. Acaster has been appointed to fill the newly created office of manager of industrial relations of the Calco Chemical Division, American Cyanamid Co.

C. William Leuth is director of research of the Jaques Manufacturing Co. of Chi-

cago. Dr. Lenth succeeds **J. R. Chittick,** who has held the post for 30 years, and who will continue actively to serve the company as technical consultant.

R. P. Hutchins, after 15 years in the development department of Procter and Gamble Co., has joined the staff of the French Oil Mill Machinery Co. as technical director of the solvent extraction division.

Frederick C. Nachod is now with Sterling-Winthrop Research Institute, Rensselaer, N. Y. Dr. Nachod was formerly with Atlantic Refining Co. in Philadelphia and with the Permutit Co. in New York.

Arno C. Fieldner, chief of the Fuels and Explosives Branch of the Bureau of Mines, received the Percy Nicols Award, given by AIME and ASME Gas Division, Oct. 24.

William T. Read has been appointed as a scientific research advisor to the Research and Development Division of the War Department's General Staff. Dr. Read represents chemistry and chemical engineering in the Scientific Liaison Group.

Ralph H. Ball, assistant director of the plastics division of the Celanese Corp. of America, is now chairman of the Paint, Varnish and Plastics Division of the American Chemical Society, succeeding **Adolph C. Elm** of New Jersey Zinc Co.

Harry A. Reed has been elected vice president of Day & Zimmerman, Inc., and will coordinate new business activities. **Thomas W. Hopper** succeeds Mr. Reed as engineering manager.

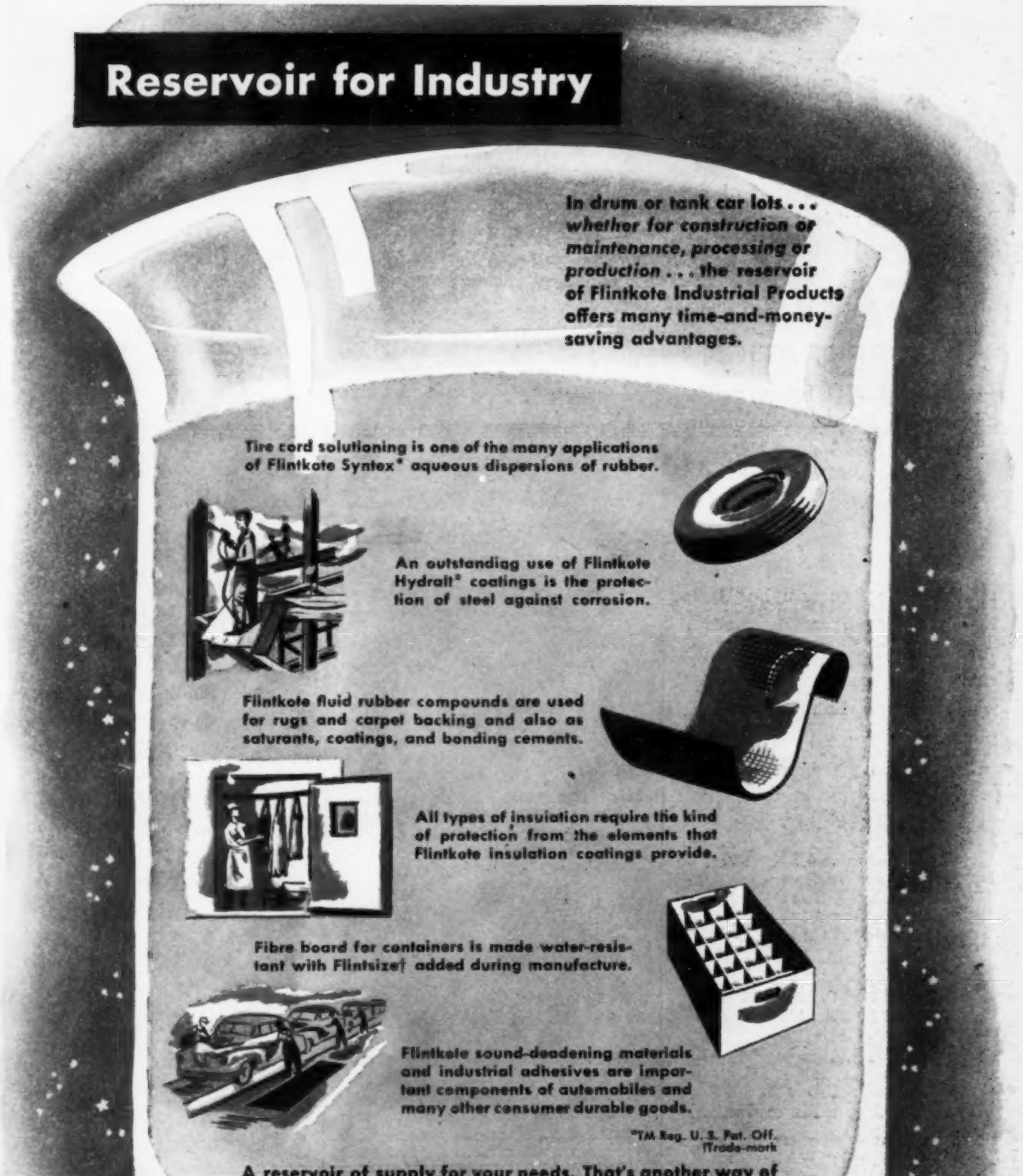
Howard K. Nason has been promoted to associate director of the central research department of Monsanto Chemical Co. in Dayton, Ohio.

Edward M. Hubbard, Milton Kosmin and **Ralph R. Werner** have been appointed group leaders at the central research department of Monsanto Chemical Co. in Dayton, Ohio.

Whitney Weinrich has joined the teaching staff in chemical engineering at the University of Pennsylvania. During the war Mr. Weinrich was a member of the refining division of the Petroleum Administration for War in Washington, and has been associated most recently with the research and chemical engineering departments of the Phillips Petroleum Co. in Bartlesville, Okla.

James N. Pryor has taken a leave of absence from the research and development department of the Davison Chemical Corp. to accept a position on the chemical engineering staff at the University of Pennsylvania. Mr. Pryor is a graduate in chemical engineering of John Hopkins University.

Charles W. Weitzel has resumed his duties as an engineer with Johns-Manville in New York after discharge from the Army. Mr. Weitzel came with the company in 1937, after graduation from Cornell University and previous employment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with Consolidated Gas Co. He is presently employed as chemical engineer for filter aids and fillers manufactured by the Celite Division for the processing industries.

G. L. Alcorn, former manager of the Weyerhaeuser Timber Co. pulp mill at Everett, Wash., is to manage a kraft mill Weyerhaeuser has under construction at Longview, Wash. Mr. Alcorn will be succeeded by **Russel J. LeRoux,** who has been associated with the Rhinelander Paper Co., Rhinelander, Wis.

Norman C. Hill is now chief chemist of the government synthetic rubber laboratory in Akron.

Nathan E. Van Stone, director of manufacturing operations of the Sherwin-Williams Co., has been appointed vice president and executive director of the special chemical products division of the company and its affiliates. **Arthur B. Holton** has been appointed technical director of paint, varnish and lacquer products.

Maurice H. Bigelow has rejoined the staff of the Plaskon Division, Libbey-Owens-Ford Glass Co., as director of technical service after Army service as a lieutenant colonel in the CWS.

Lawrence L. Jones has been named superintendent of General Electric Co.'s new factory for the manufacture of Glyptal alkyd resins at Anaheim, Calif.

Robert Gottschalk has joined Standard Oil Co. (Ind.) as assistant manager of the development and patent department.

J. W. Dykes, formerly manager of the pharmaceutical manufacturing division at the Bound Brook plant of Calco Chemical Division, American Cyanamid Co., has been named production manager of the new Willow Island, W. Va., works of the company. **Harold T. Lacey** is now senior chemist of the new Willow Island works, and a member of the technical committee of the company's Marietta works, Marietta, Ohio.

James F. Bourland is now chief chemist in the pharmaceutical department of the new Willow Island works of Calco Chemical Division, American Cyanamid Co.

Byron Elmer Lauer, former professor of chemical engineering at North Carolina State College, and recently in charge of procurement of war materials for the construction division, Office of Inspector General, has been appointed professor in the department of chemical engineering at the University of Colorado, Boulder.

Robert B. Coons, senior partner in Coons, Milton & Co., San Francisco, has joined the executive staff of American Potash & Chemical Corp., Los Angeles. Mr. Coons will give up his general partnership with Coons, Milton & Co., but will remain identified with its activities.

Gordon A. Boelter, formerly production superintendent of Goodyear Synthetic Rubber Corp., Los Angeles, has been ap-

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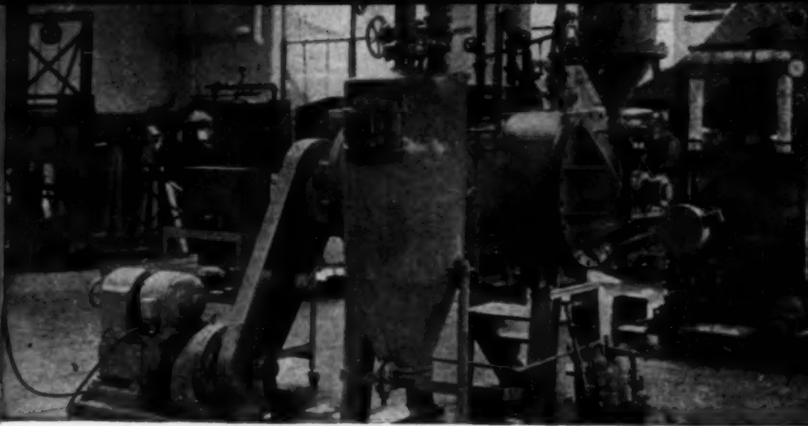

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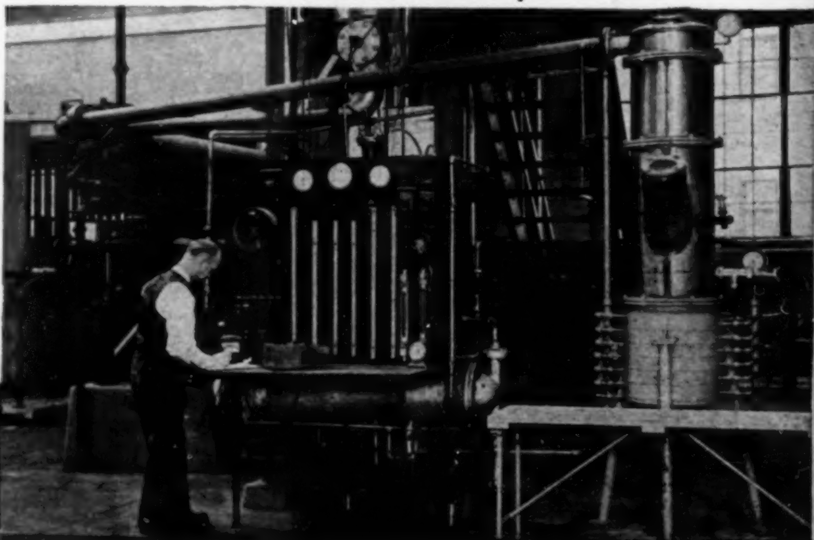
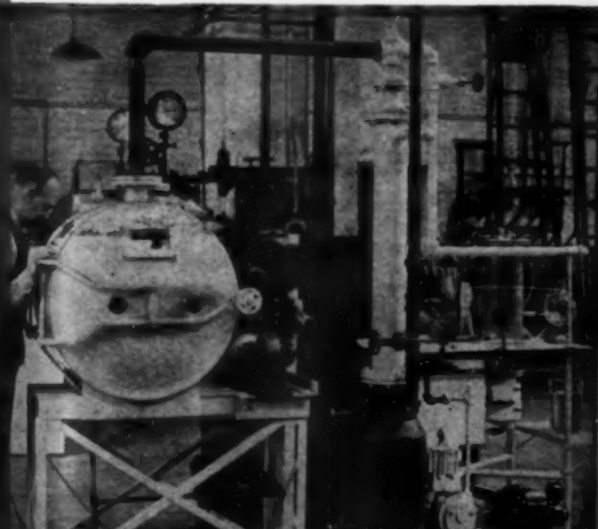
Some of the Evaporator equipment in the BUFLOVAK Research Laboratory.



Vacuum Double Drum Dryer and Experimental Evaporator in the BUFLOVAK Research Laboratory.



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pointed plant superintendent to succeed **Jack K. Lockridge,** who has become manager of the new plastic production division of Goodyear Aircraft Corp., Akron, Ohio. **Benjamin A. Rosinski** will replace Mr. Boelter as production superintendent.

Charles Tichy is the new general manager for the Reynolds Metals Co. aluminum extrusion plant, Phoenix, Ariz. **William F. Hunt** is the new chief engineer.

Donald J. Will has been elected president of Stuart Oxygen Co., San Francisco. **Patrick Coyne** assumes the presidency of the company's subsidiaries, Standard Acetylene Co., Ltd., Oakland; Valley Oxygen Co., Hanford, Calif.; and Pacific Carbide & Alloys Co., Portland.

Roland V. Rodman, vice president and general manager of Bay Petroleum Corp., has been named president, succeeding **Charles U. Bay,** who has been chosen chairman of the board of directors.

Thomas E. Brown has been appointed assistant superintendent of the Bacchus, Utah, plant of Hercules Powder Co.

C. Burke Miles has been appointed director of the Newark, Calif., division of the technical department of Westvaco Chlorine Products Corp.

Carleton Ellis, Jr., has returned to his position of manager of the new products division of the Plaskon Division of Libbey-Owens-Ford Glass Co., after active duty as a Navy lieutenant.

Charles C. Randolph, Jr., and **Baxter Blitz** are now administrative assistant to the manager and resident engineer, respectively, at the Willow Island works, Calco Chemical Division, American Cyanamid Co.

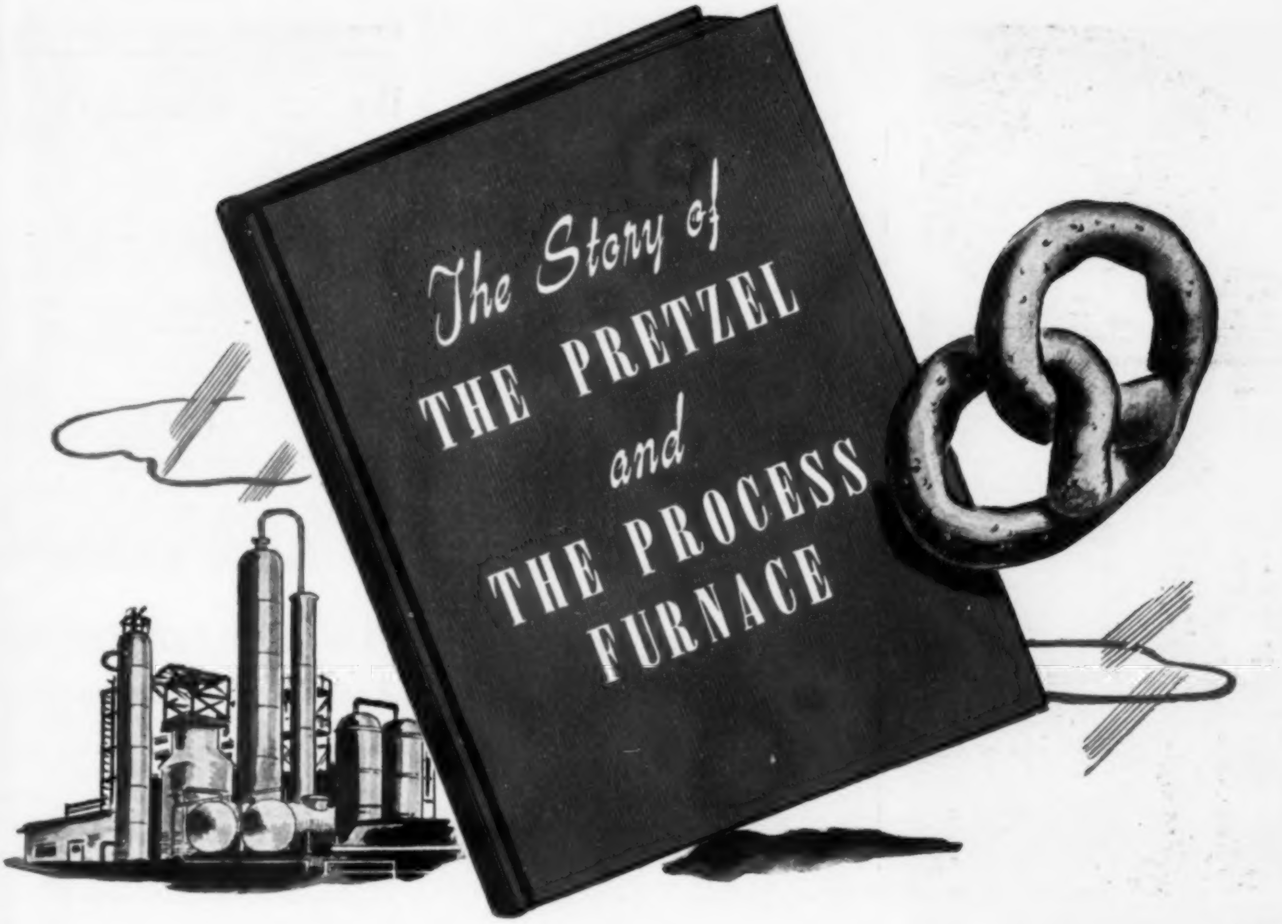
C. C. Crawford has been appointed assistant manager of the chemical products department of Phillips Petroleum Co. Dr. Crawford is in charge of the special products, product development, and Perco divisions.

Don R. Carmody is now supervisor of process research at the Texas State Research Foundation. Other recent additions to the staff include: **Edward R. Boedeker, John R. Clopton, Alex G. Oblad** and **Lorld G. Sharp.**

Howard W. Morgan, who resigned recently as vice president of Munising Paper Co., Munising, Mich., will assume active duty as manager of the pulp division of Weyerhaeuser Timber Co., Longview, Wash. Mr. Morgan succeeds **R. B. Wolf,** who has been manager since the company built its first mill in 1931.

Benjamin D. Van Evera, professor of chemistry and executive officer of the chemistry department has been appointed co-ordinator of scientific activities, a newly created office at George Washington University.

Bert S. Taylor has been named factory manager in the newly created plastics production division in The B. F. Goodrich Co. **Robert H. Wattleworth** has been



YOU WOULDN'T THINK a pretzel had any relation to a chemical process furnace. But it does, and here's why:

A baking company recently lined a pretzel oven with B&W K-20 Insulating Firebrick. Immediate results—*50% reduction in baking time (6 minutes to 3 minutes) and over 57% reduction in heating-up time from a cold start (7 hours to 3 hours).*

Of course your business is different, but whether it's bending pretzels or bending molecules, in polymerization, pyrolysis, heating, distillation or any other chemical process—it's B&W I.F.B. that helps to do the trick better and more economically. Because they are the lightest in their class, B&W I.F.B. have the lowest heat conductivity and lowest heat storage capacity. Furnaces lined with B&W I.F.B. come to operating temperature quickly, require less fuel to operate. This means cycle time is often substantially cut; overall operating costs go down—production goes up.

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named general superintendent of the processing division to succeed Mr. Taylor.

William L. Wasley, formerly assistant professor of chemistry at Washington University, St. Louis, Mo., joined the research staff of Ansco's general research department in the capacity of group leader.

Frank J. Kaszuba and **Hermann Hoerlin,** respectively, have been named managers of the chemistry and physics laboratories—two new posts in the general research department of Ansco, Binghamton, N. Y.

Chad Raseman has joined Boyle-Midway Inc., household products division of American Home Products Corp., as chemical engineer for its five plants.

John D. Rue is now works manager of the Tacoma, Wash., plant of Hooker Electrochemical Co. Mr. Rue, formerly located at Niagara Falls as executive assistant to the chief engineer, has been with Hooker since 1931.

OBITUARIES

William E. Smith, 73, former president of the Standard Oil Co. of Kentucky, died in Louisville October 2.

De Lancey Kountze, 68, chairman of the board of Devoe & Raynolds, paint manufacturers, died in New York October 2.

Ignace Moscicki, 78, former president of Poland and a well-known electrochemist before he went into politics, died in Switzerland October 2.

Walter Douglas, 75, former president of the Phelps Dodge Corp., died in Chauncey, N. Y., October 3.

Joseph H. Percy and **R. Max Goepp, Jr.,** were killed in the crash of the American Overseas Airlines plane near Stephenville, Newfoundland. Dr. Percy was enroute to Germany to investigate synthetic detergents. He was director of chemical products, division of research and development, Colgate-Palmolive-Peet Co. Dr. Goepp was returning to Germany to complete a study of emulsifiers and detergents. He was director of organic research for the Atlas Powder Co. The accident occurred October 3.

Rudolf Zane, chemical engineer with the U. S. Bureau of Mines, Seattle, Wash., on his way to Germany to translate captured scientific documents, and Mrs. Zane were also among the victims of the plane crash of October 3.

Frederick M. Prall, 52, director of the Rayon Technical Patent Section of E. I. du Pont de Nemours & Co., died in Wilmington October 11.

Andrew L. Winton, 82, prominent chemist and food plant histologist, died in Wilton, Conn., October 17.

Frederic Juenger, 63, traffic manager of the Texas Gulf Sulphur Co., died in New York October 21.

INDUSTRIAL NOTES

Johns-Manville Corp., New York, has elected Lewis H. Brown chairman of the board of directors and chief executive officer. R. W. Lea has been elected president. The general managers of the six operating divisions appointed by the new president are: J. A. O'Brien, industrial products division; Harold R. Berlin, building products division; A. S. Elsenbast, celite division; and E. C. Brockett, Canadian products division. E. S. Crosby continues as general manager of the international division. A. R. Fisher, vice-president for production, will act as general manager of the asbestos fiber division.

United States Rubber Co., New York, has promoted James E. Stevenson to the position of manager of V-belt sales. George R. Vila has been moved up to the post of sales manager for latex, Lotol, rubber dispersions and plastics products.

Pennsylvania Salt Mfg. Co., Philadelphia, has placed Louis M. Kuilema in charge of the Wisconsin territory as district sales manager. His offices are located in Chicago.

C. B. Peters Co., New York, has been reactivated by Col. Carl B. Peters who was recently separated from the United States Army. Offices are located in the Graybar Building, 420 Lexington Ave., New York 17, N. Y. The company will again concentrate on materials of interest to the fertilizer, chemical, explosive and soap industries.

E. I. du Pont de Nemours & Co., Wilmington, will establish a Grasselli Chemicals department district office in Minneapolis. On January 1, the company will handle the sale of acids, chemicals, insecticides, and agricultural products from the new office which will be located in the Foshay Tower.

Steel Improvement & Forge Co., Cleveland, has established a turbine forgings division with Carl I. Schweizer in charge. The company also announced the appointment of Arthur Zimmerman as sales manager.

SKF Industries, Inc., New York, has named Harrison Wood as New York district manager to succeed John D. Williamson who has resigned after heading the district for the last 23 years.

Dow Chemical Co., Los Angeles, announces that Howard P. Atkin, after four years service with the Army Air Corps, has recently become a member of the company's cathodic protection sales staff.

Fluor Corp., Ltd., Los Angeles, has promoted W. Earl Dunn to the post of general manager. James P. Wiseman, former district engineer in the Houston office, has been moved up to the post of general

sales manager. Both men are now located in the Los Angeles office.

Elliott Co., Jeannette, Pa., has appointed Quentin Graham manager of the Ridgway (Pa.) division. Mr. Graham was formerly manager of the company's electrical engineering department. H. S. Pahren, former manager of the division has moved to New York as Elliott district manager.

Joshua Hendy Iron Works, Sunnyvale Calif., announces that Joseph H. Wadsworth, formerly with California Shipbuilding Corp., has been appointed director of public relations.

Sier-Bath Gear and Pump Co., North Bergen, N. J., is the new name of the former Sier-Bath Gear Co., Inc. The company is located at 9252 Hudson Blvd.

Parke, Davis & Co., New York, has awarded engineering and construction contracts for a new building in Detroit to house the production and development of streptomycin and other antibiotics to the H. K. Ferguson Co. The four story structure will provide office, laboratory, process and development facilities. Construction is now under way.

Maas & Waldstein Co., Newark, N. J. has purchased the Smith-Davis Paint Co., 10751 Venice Blvd., Los Angeles. The company will continue to manufacture industrial finishes, trade sales and maintenance sales paints. C. R. Parry will supervise the new plant.

Pittsburgh Plate Glass Co., Pittsburgh, has acquired the Mork Brush Mfg. Co., San Francisco. The unit will continue operations as the Mork Brush division of the company.

Atlas Mineral Products Co., Mertztown, Pa., has a new affiliate organization called Atlas Mineral Products Co. of Texas, Inc. It is located at Houston and includes a plant manufacturing sulphur cements and other products. The Texas unit handles sales in western Tennessee, Mississippi and Louisiana. It also handles all sales west of the Mississippi with the exception of Minnesota, North Dakota, and eastern Missouri.

Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y., has changed the name of its oil soluble resin division to protective coating resins division and the name of its technical sales division to industrial sales division. These changes were made to clearly define the functions of the departments.

Komline-Sanderson Engineering Corp., Ridgewood, N. J., has been formed for the purpose of developing and marketing machinery and equipment for the treatment of sewage and industrial wastes. Partners in the concern are Thomas R. Komline and Walter H. Sanderson.

Shell Chemical Corp., New York, has appointed Merle L. Griffin to the post of assistant to the western division sales manager. He was formerly assistant to the

general manager in New York. V. C. Irvine has been named manager of head office sales development in San Francisco.

Brill Equipment Co., New York, has made Stephen M. Schuster advertising manager. Mr. Schuster was recently released from active duty in the Navy.

Bowser, Inc., Fort Wayne, Ind., has placed J. C. Lungerhausen in the post of chief development engineer in the industrial pump division.

Esselen Research Corp., Boston, is the new firm name of Gustavus J. Esselen, Inc. There will be no change in the management, personnel or policies of the business.

Rhodes Industrial Corp., East Hampton, N. Y., has been formed by Philip H. Rhodes. The new firm has offices and laboratories in that city. Officers of the company are: P. H. Rhodes, president; A. L. Alk, treasurer and chief chemist; and E. Libby, director of pilot plant operations.

Hydraulic Press Mfg. Co., Mount Gilead, Ohio, has appointed Col. Robert F. Ohmer vice president in charge of administration.

Oronite Chemical Co., San Francisco, has announced appointment of H. E. Bramston-Cook as sales manager, national and international, for the firm's new synthetic detergent, phthalic anhydride, and other chemical products. Oronite has just moved to new headquarters at 200 Bush Street, San Francisco.

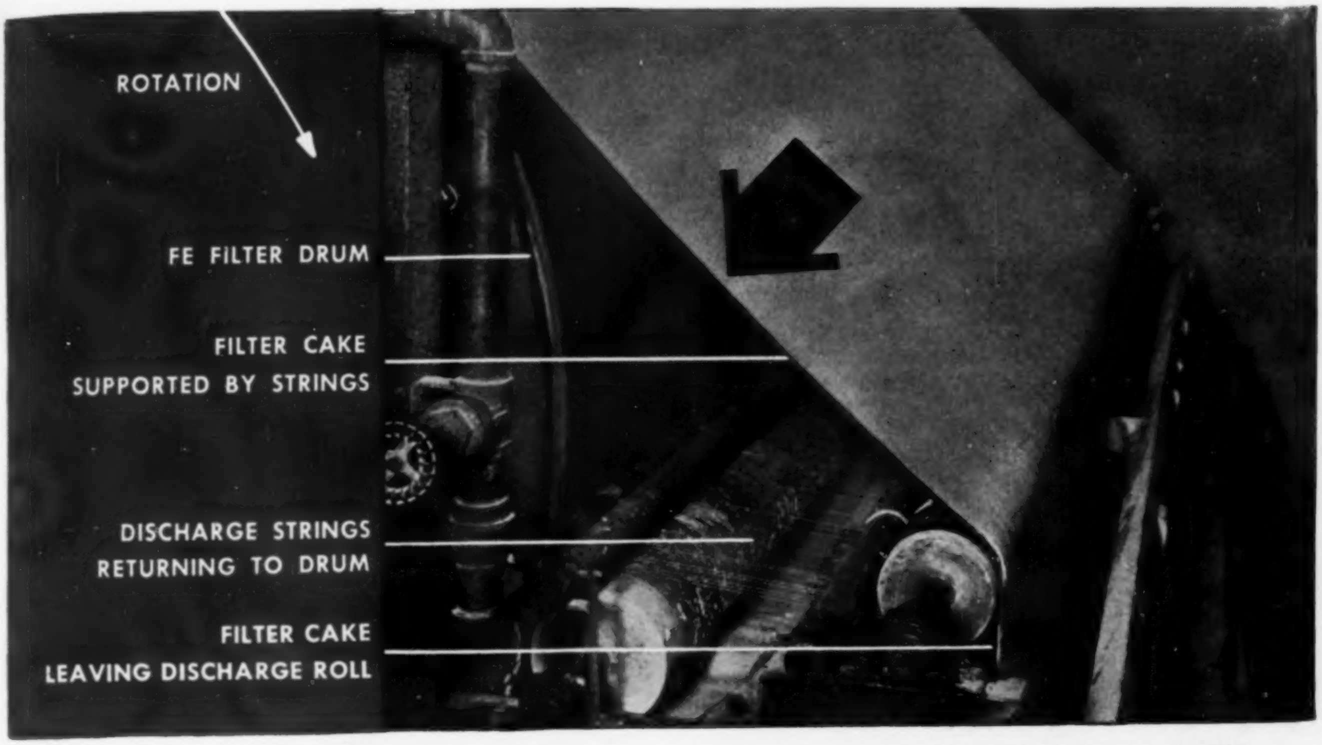
American Marietta Co., Chicago, has purchased Adhesive Products Co. of Seattle and Pacific Chemical Co. of Los Angeles. The company also bought two Seattle paint plants a year ago.

W. E. Major Industries, Los Angeles, has recently been organized with W. E. Major as president to act as exclusive agents for chemical products of the iron and steel division of Kaiser Co., Inc., Growers Chemical Supply Co., and Wilson Carbon Co., and as non-exclusive agent for the coal-tar and chemical products of Geneva Steel Co. and of Union Oil Co. of California. Mr. Major for many years West Coast manager for General Chemical Co., was recently manager of the chemical division of Union Oil in Los Angeles.

A. Brothman and Associates, Long Island City, N. Y., has moved from 114 East 32nd St., New York, to 2928 41st Ave., Long Island City 1, N. Y.

Young Radiator Co., Racine, Wis., has promoted Peter J. Fink to the post of service manager. Lloyd B. Smith has been made special representative in the Pacific Northwest territory.

American Cyanamid Co., New York, has made the following changes in the Calco Chemical division: John B. Fried has been made a metropolitan New York district sales representative in the pigment department; Wendell G. Beauchamp is now



FILTER CAKE IN ONE CONTINUOUS SHEET... WASHED CLEAN—THOROUGHLY DEWATERED

This easy-to-process filter cake is being discharged from an FE Chemical Washing Filter. Built up to just the right thickness on the filter drum, it has been thoroughly washed, and dewatered. As you see it here, it has just been lifted off the surface of the revolving filter drum by the FE string discharge (no scraper), and is being carried (still supported by the strings) to the discharge roll.

The uniform filter cake pictured above is just one of the many results you can achieve with FE continuous filtration. FE filters are basically *good,* sturdy, trouble-free vacuum filters to which can be added exclusive FE features that improve washing, produce lower cake moistures, and improve results—all at lower costs.

The FE string discharge does away with scrapers and "blow-back." No wire winding is needed to hold the filter cloth in place, and no severe mechanical strain or abrasive wear shortens the life of the cloth. It permits handling filter cakes as thin as 1/16 in., and successfully filters semi-colloidal slurries and "slimes." Cloth changes are less frequent, and can be made in a fraction of the time required for scraper-type filters.

The FE compression mechanism can be added to squeeze 2 to 6% more moisture out of the filter cake. It also reduces vacuum power requirements by closing up cracks that may occur in the cake.

Better cake washing is possible with the FE washing mechanism. Less residual impurities and better recovery of solubles result from the non-atomizing, uniform, water wash that is spread evenly over the entire cake with the help of a highly absorbent wash blanket. Both the washing and dewatering cycle are long—you get a clean cake with minimum moisture.

FE filters are available in sizes from 9 to over 700 sq. ft. filtering area, for handling a wide variety of materials including chemicals, food products, paper pulp, mining slimes and concentrates, sewage sludges, clay, sugar muds, starches, cements and many others. We will be glad to help with your filtration problems.

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Pacific coast regional sales manager of the pigment department; M. H. Mettee III has been transferred to plastics sales for the dyestuff department; and George A. Jonic has been named a sales representative in the metropolitan district.

Diamond Alkali Co., Pittsburgh, has appointed Donald S. Carmichael of Cleveland, assistant secretary of the company. He has been located in the main office since November 1.

Edwal Laboratories, Inc., Chicago, has added Herbert C. Stecker to its staff. He will serve as assistant to Dr. Hendrey who is in charge of chemical sales.

Beaumont Birch Co., Philadelphia, has purchased the complete line of Hagan steam jet ash conveyors from the George J. Hagan Co. of Pittsburgh.

Centro Research Laboratories, Inc., Briarcliff Manor, N. Y., announces that Dr. Vaman R. Kokatnur, president of Autoxygen Inc., has joined its staff as research associate but will retain his New York office for chemical consultation.

Foxboro Co., Foxboro, Mass., has under construction a new plant for its affiliate, The Foxboro Co., Ltd., in the Ville LaSalle section of Montreal, Canada. It will be ready for operation in the spring.

Rheem Research Products, Inc., Baltimore has appointed the Mitchell-Bradford Chemical Co., Stratford, Conn., as exclusive distributor for Iridite in the New England area.

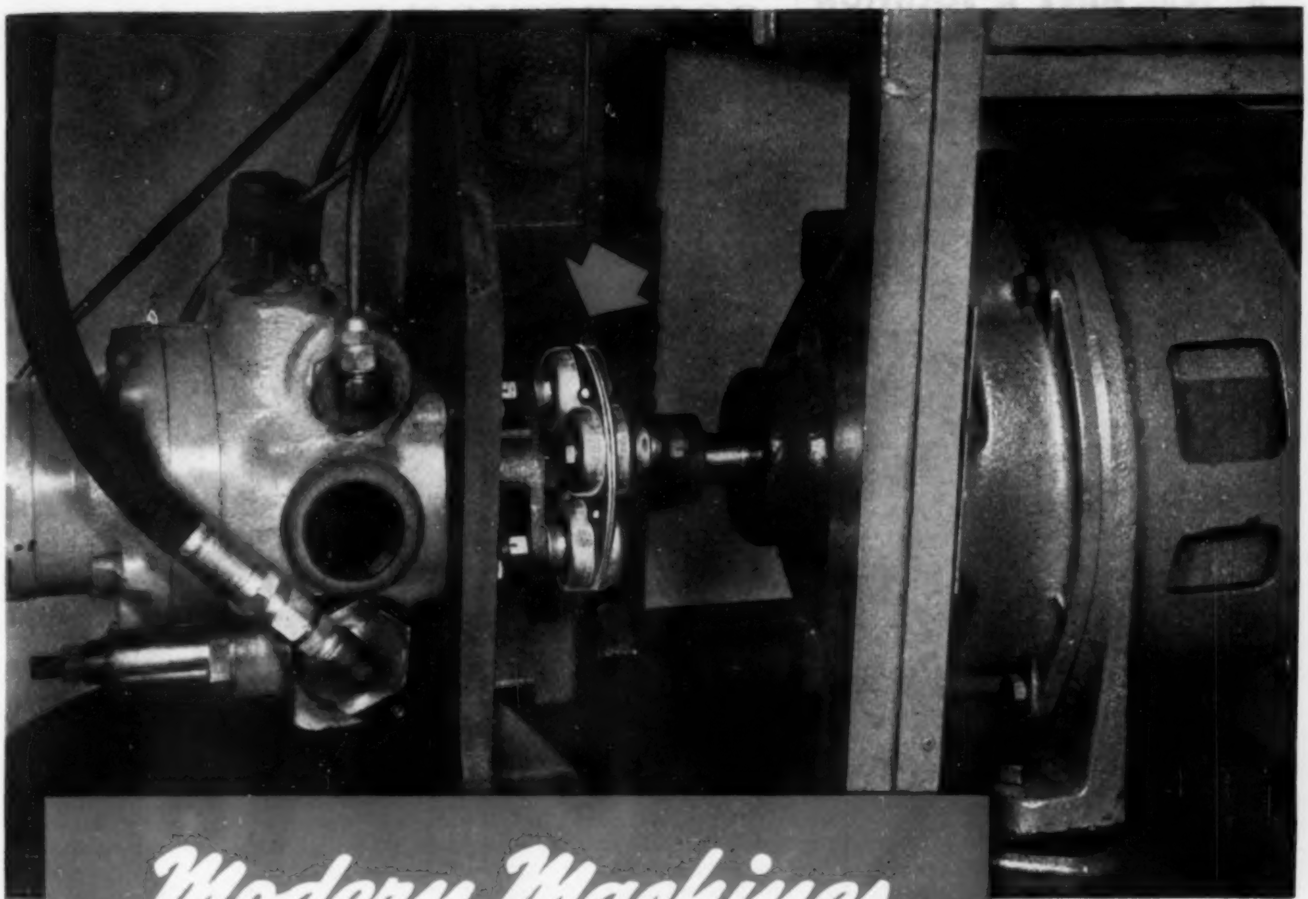
James Stewart & Co., New York, has elected James M. Jensen to the newly created position of assistant to the president. Mr. Jensen, who has been with the company for 31 years, had been serving as project manager in charge of the company's construction of pulp and paper plants at Macon, Ga.

Pittsburgh Lectrodryer Corp., Pittsburgh, has appointed D. B. Gooch, Birmingham Ala., as sales representatives for all of the Carolinas and parts of Alabama and Georgia.

Timken Roller Bearing Co., Canton, Ohio, has transferred Russell P. Proffitt from Chicago to the Washington office where he will serve as district manager.

Logan Engineering Co., Chicago, is now represented in the Southwest, Mexico, and Central America by the Patterson Sales Co. of El Paso, Texas.

E. I. du Pont de Nemours & Co., Wilmington, has opened an office for the organic chemicals department at Atlanta. The Charlotte, N. C., office which formerly handled sales south of Virginia will concentrate on North and South Carolina. D. C. Newman will continue as sales manager in charge of the entire southern district. A. B. Owens, formerly sales development manager of the dyestuffs division at Wilmington, will be manager of the Atlanta office.



Modern Machines Deserve MORFLEX Couplings

Chicago Pneumatic Tool Company's portable hydraulic system, adaptable to cold riveting, piercing, pressing and pulling operations, uses Morflex Couplings on the power unit shaft between motor and pump. Morflex Couplings absorb shock, vibration, prolong machine life in the severest service. MORSE CHAIN COMPANY, Detroit 8, Michigan; Ithaca, N. Y.

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CONVENTION PAPER ABSTRACTS

CONTENTS

THE ATOMIC ENERGY ACT

The famous "Atomic Energy" Act of 1946, which was passed by Congress and signed by the President, is an example of the unfortunate tendency toward compulsory licensing of patents and the extension of government control. The Act, while professing to be interested in continued research and development activities in the field of nuclear processes, the production of atomic energy, and the utilization of fissionable and radioactive materials, discourages the making and development of inventions in that field by establishing a tight government control over sources of material, such as uranium and thorium; fissionable material including the artificially produced plutonium and uranium enriched in the isotope 235; byproduct material; facilities for the production of fissionable materials; and the utilization of atomic energy. At the same time, it provides that inventions and discoveries in the production and utilization of fissionable material shall not be the subject matter of patents.

It does not seem consistent that, while patents have in the past been the great stimulating force promoting the making of inventions, this force should be removed in connection with the very important field of atomic energy. True, the Act provides for so-called "just compensation" for the inventor, but as almost everyone knows, what might be considered such by a Commission, might be hardly adequate to satisfy the inventor. In any event, an inventor would not have the incentive that he would have had under a free right to invent and patent his inventions, in accordance with the patent law as it stands aside from the Atomic Energy Act.

Besides this, the Act provides for compulsory licensing of patents already granted in the atomic energy field, making it the duty of the Commission to declare any such patents affected with a public interest.

So the Act is deplored as tending to weaken the rights of inventors by taking from them the right to patent within a specified field. It might be urged that the field is well-defined, but this is not so. Although at the present time, the sources of fissionable material are practically limited to uranium and thorium, who can tell

but that other sources may not be found, or that other materials not at present considered fissionable may not eventually be found to be in that category. Suppose that copper is eventually found to be fissionable, that would take the great copper industry from private enterprise and put them under government control.

Towson Price, Westinghouse Electric Corp., before Radio Business Forum, New York, Oct. 1, 1946.

OBSTACLES IN THE WAY OF RESEARCH

WHAT of the future of research? With its past record one may wonder why further incentives for research are needed. The fact is, however, that in spite of this history of achievement there are some serious clouds on the horizon, which threaten the ability of research to continue its vital contribution to the life of our nation. One such cloud is the fact that the simpler and easier problems have been solved. We are left with the more difficult ones. The law of diminishing returns is beginning to apply to many fields of research.

A second obstacle to research is the serious shortage of technical men which faces us, particularly during the next five years. As industrial operations become more complex, technically trained men are needed as operators or supervisors, and such jobs generally have priority over research. It will be impossible for our educational institutions to meet the demand for technical men during the next several years. This shortage stems back largely to the shortsighted policy pursued by the military authorities in drafting thousands of technical men for non-technical jobs, and particularly in uprooting almost completely the young students who were part way through our technical schools.

Third difficulty in expanding our research program is the accumulated deficiency in basic research. During the war we made tremendous advances in applying known principles of science, but we discovered very little that was basically new or fundamental. This is one field where we have been drawing upon our reserves at an alarming rate.

Fourth threat to the future of research arises out of the attempt of a relatively small group to wreck our patent system. They have misrepresented the basic facts about patents and have filled the papers with discussions of a few unusual and nontypical patent-control schemes, with which our antitrust laws are quite adequate to deal.

R. E. Wilson, Standard Oil Company of Indiana, before Princeton University Bicentennial Conference, Oct. 4, 1946.

FERTILIZER INDUSTRY FORECAST

WHEN the supply and demand for fertilizers strike a balance again, there will be a shaking out of the distribution pattern not possible during the restrictions of the war years. The assimilation of war-built nitrogen fixation plants into our peacetime economy has begun. The construction and operation of phosphate mining

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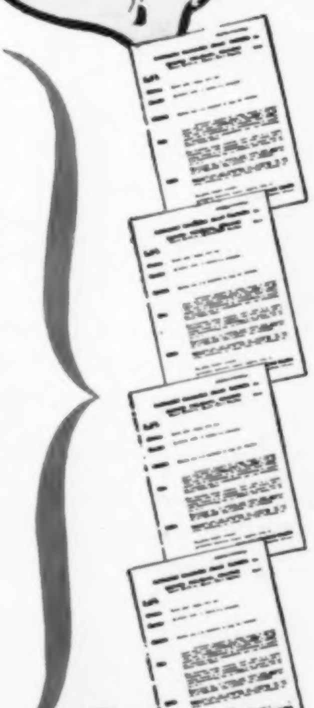

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and processing facilities is well started. It will continue with emphasis on ability to serve the recently enlarged demand in the north central and west coast areas.

During the five year prewar period, 1935-1939, agriculture in the United States used an average fertilizer volume of 7¼ million tons annually. By 1945 this had increased 81 percent to 13.2 million tons. The fact that the major plant nutrients contained in that tonnage increased during that same span of years more than 86 percent is an indication of a sound trend which we can be certain will continue.

Through the fertilizer industry, agriculture in the United States purchases more than 13 million tons of chemicals. For the year ending June 30, 1947, prospects are that a 14 million ton total will be so delivered as one of the important contributions toward an abundant food supply.

Barring interruptions of supply, this will be 91 percent more ton volume and 103 percent more of the three major plant nutrients than was used on an average during the five years 1935 through 1939.

From an industry using large proportions of natural organic byproducts, fertilizer manufacture has changed in less than a generation to a business of predominantly inorganic chemical nature. Even as long ago as 1925 only one-fourth of fertilizer nitrogen used here in the United States was from natural organics. By 1940 this proportion had decreased to one eighth. For the year ending next June 30 there will be a further decline to less than one-twentieth. Conversely ammonia and its solutions which in 1925 had as yet assumed no measurable percent of the fertilizer nitrogen supply picture, had claimed one eighth of the market by 1940. They bid fair to make up one-fourth of the total this year. Solid ammonium nitrate, of which little or none was used as fertilizer in this country in 1925, has now assumed one-fifth of the market.

Phosphates in the fertilizer industry have also undergone some changes and made progress, critics of the industry notwithstanding. Phosphate rock recovery processes and volume have been stepped up. Fused phosphates have recently entered the picture and will apparently amount to about one hundred thousand tons of material for the current year.

Maurice H. Lockwood, National Fertilizer Association, before the Chemical Market Research Association, New York, Sept. 17, 1946.

CHECKING CORROSION OF OIL WELL PIPELINES

Corrosion has become an increaseingly serious problem in the oil fields because of the high pressures at which the wells operate and the danger of resultant accidents. The corrosive attack, due to carbon dioxide, water, and organic acids, is erratic, and wells standing side by side do not show the same effects or the same intensity of effects.

Gas condensate wells themselves were used as a laboratory to study the action of the gas stream on the interior of the pipes through which the gas is produced. From the data gathered, the wells were grouped

into three general types, critical, non-corrosive, and intermediate.

In the critical corrosive type not only has the rate of attack been steady and severe, but small deep holes appear in the metal. Another type was the protective attack in which, after an initial attack, there was little if any further attack until that surface was removed. No pitting and very little penetration or corrosion of the steel takes place with this type of well.

The third type noted was intermediate between the corrosive and so-called non-corrosive well. In this type well the corrosion takes place at a slow steady rate. Local attack and pitting do not seem to take place. This type of corrosion is not as serious since the even, general effect permits accurate calculation of the life of the pipe. Thus by observation of the weight change of a pipe and microscopic examination of the surface a means of predicting the corrosive behavior of the well could be established.

Corrosive agents and operating conditions were similar in the corrosive and non-corrosive type wells, indicating that the non-corrosive well contained a substance which reacted with the surface of the pipe to provide a protective film, arresting the corrosion.

The naphthenic acids were believed to meet the requirements and could conceivably be present under these conditions. A laboratory test showed that the addition of a very small amount of this acid formed a protective film which inhibited the attack of organic acid. Injection of naphthenic acid into a corrosive type well also seemed to be effective. Not only was there little metal lost, but more important, the surface became similar to that demonstrated by the non-corrosive well and no pits formed.

Tests with sodium chromate or dichromate showed a slight initial attack followed by little or no change over a period of eight weeks.

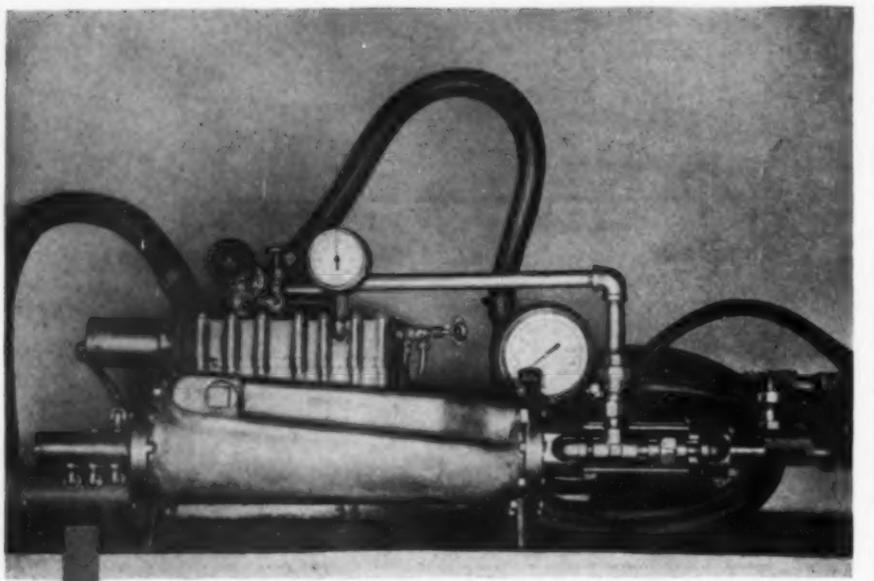
Norman Hackerman and D. A. Shock, University of Texas, before the Division of Industrial and Engineering Chemistry, American Chemical Society, Chicago, Sept. 12, 1946.

RUBBER REINFORCED WITH LIGNIN

In a new process, lignin is mixed with either synthetic or natural rubber in latex form so that it is coprecipitated or coagulated with the rubber, forming a material ready for compounding and molding by the usual means. The process may be adapted, with minor variations, to most of the plants now making synthetic rubber.

Rubber articles strengthened and toughened with lignin reveal unusual properties. One of these is light weight. Lignin is only 72 percent as heavy as carbon black. Used in rubber tires, lignin could save approximately 7 percent of the weight of the tire. In other rubber goods where more pigments, heavier than carbon black, are used, the saving in weight is considerably more. Thus, shoe soles or heels are 35 percent lighter when lignin is used.

Lignin also offers another advantage, long sought by the rubber industry—light, bright-colored articles that are as tough and



strong as those of black rubber. Light colors are possible because lignin has itself a comparatively weak tinting power. Its natural dark brown color fades out on blending with minor proportions of white pigments and colors. The small amounts used do not impair the strength or toughness of the rubber except where near-white shades are desired.

Lignin-reinforced rubbers also provide advantages to the rubber converter. Lignin-coprecipitated rubber requires only one-fifth the breakdown time and the time for mixing pigment is eliminated entirely.

Lignin can serve a dual role in coprecipitation processes for other reinforcing pigments. The use of lignin as dispersant has the considerable merit that it actually aids coprecipitation and that after coprecipitation the lignin remains to act as a reinforcing pigment.

This process of reinforcing with lignin can be applied to any rubber which occurs in latex form. In using lignin an alkaline solution is first made and this is then mixed with latex in the desired proportions. The lignin and rubber are then precipitated together. This coprecipitate, or crumb, is then filtered and dried. The principal change in equipment over that now in use is in the type of filters. When suitable filters are installed, their use also offers other manufacturing advantages.

The tensile strength of lignin-reinforced rubber compares favorably with that of rubbers containing the best reinforcing pigments known. At loadings higher than normal lignin provides higher tensile strengths than any other material tested.

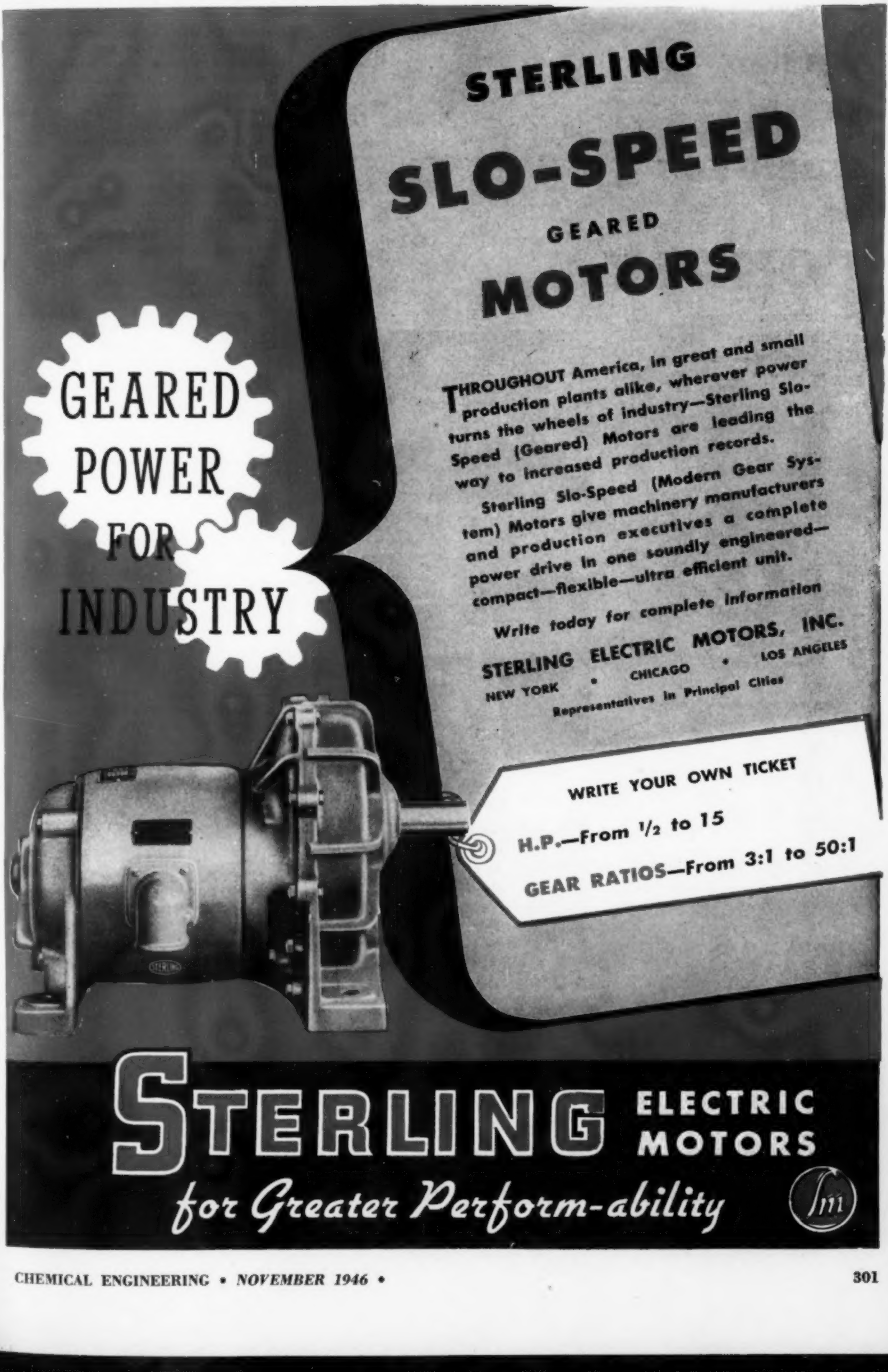
J. J. Kellen and Arthur Pollak, West Virginia Pulp and Paper Co., before the Rubber Division, American Chemical Society, Chicago, Sept. 13, 1946.

GERMAN ECONOMY SHOULD BE BALANCED NOW

It is better to have Germany attain a balanced economy, even if a much larger proportion of German war-potential industries must be retained than is now planned. Proper control of such industries by competent representatives of the four occupying powers, perhaps over an indeterminate period, would then be a "must." Without a balanced economy in Germany, the future economy of Europe is at stake. Existing conditions are strangling German enterprise and bringing the population daily closer to starvation. A feeling of hopelessness pervades German life today.

In addition to the crippling curtailment of heavy industry, most vital part of the country's prewar industrial life, the Allies' delay in carrying out the Potsdam agreement to treat Germany as an economic unit is wreaking havoc in all four occupation zones. At present, in none of the four areas can the occupation be designated as successful. The drastic conditions of economic life stemming from the firmly maintained trade barriers are too apparent for contention.

There appears to be no firm basis for the future reestablishment of a normal, non-aggressive state, willing and eager to earn its way back to acceptance into world accord. Hundreds of millions of American taxpayers' dollars are now flowing abroad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annually to keep Germany running. Large expenditures will be necessary so long as a balanced economy is not reached. The American people are unlikely to agree complacently to contribute to Germany's economy for more than two or three years.

Under these circumstances, what usually results is an investigation by a Congressional committee. The findings may be that the regulations are too severe, and the subsequent recommendations that the controls should be relaxed.

The danger is that future leniency may go beyond the measure of advisability.

Roger Adams, University of Illinois, before American Chemical Society, Chicago, Sept. 11, 1946.

HUMAN FACTORS AFFECT EFFICIENCY AND COSTS

Chemical processes of the future must be designed with more appreciation of the human factor. Regardless of how a design corresponds to the various codes, it will not run at top efficiency if it does not take into account the safety and health of the people who have to operate it. With the industrial trend toward higher operating pressures, the production and transporting of more highly flammable and more highly toxic substances, the need for greater emphasis on chemical process safety becomes imperative.

Greater emphasis should be placed on safety in engineering in the professional schools, however, it should be an integral part of all courses rather than a separate study in itself. In methods used to protect personnel, property and product against loss by accident, fire, explosion or toxic properties, greatest attention must be given to the human element since it is responsible for over 80 percent of all accidents.

Much more progress in industrial safety will be made when the emphasis is shifted from the humanitarian point of view, commendable as it is, to the production point of view of efficiency and cost.

William F. O'Connor, New York University, before the Industrial and Engineering Division, American Chemical Society, Chicago, Sept. 9, 1946.

RECTIFICATION FOR THE ELECTROLYTIC INDUSTRIES

During the war the a.c.-d.c. conversion equipment in the electrolytic industry was expanded to 4.5 million kw. The major part of such conversion equipment is in aluminum, magnesium, chlorine, copper and zinc. At the peak of operation during the war, these five processes consumed approximately 31 billion kwh. annually. This is more energy than is consumed by any other single industry.

Nearly all of the conversion equipment installed in the aluminum industry since 1931 has been of the mercury arc rectifier type. The only complete and new installation of rotating apparatus covers gas-engine-driven d.c. generators installed during the war because of a shortage of power. They were installed in a location where natural gas was plentiful.

Of the approximately 525,000 kw. of conversion apparatus installed for magne-

sium production, 75,000 kw. are in rotating apparatus and the remainder in mercury arc rectifiers.

There are so many different kinds of chlorine cell lines that it is difficult to compile very complete data on them. About every type of conversion equipment is represented and many operating voltage levels. Approximately 175,000 kw. of conversion equipment is in mercury arc rectifiers and 115,000 kw. in rotating apparatus.

Zinc and copper cell lines usually require about 10,000 amp. Zinc cell lines have usually been installed at 500 to 600 v., while copper cell lines have been installed at 200 to 300 v. Some foreign installations have been made using voltages up to 800 or 850 v.

For normal operation, the cell line is operated at substantially constant d.c. voltage. Where rectifiers are applied to zinc lines, the voltage adjustment has been obtained by regulating transformers or grid control. There have been no rectifiers applied, in this country, to copper processes, probably because of the low d.c. voltage requirements and because of the state of the art at the early dates at which most of the copper lines were installed.

The mercury arc rectifier has become well established in the electrochemical field. While there were several individual rectifier installations in the electrochemical industry prior to 1935, rectifiers can be considered to have become generally acceptable at about that time. Large rotating apparatus installations made before 1935 are not evidence that rectifiers were unsuitable.

Industry	Roating D. C. Kilowatts	Rectifier D. C. Kilowatts	Total
Aluminum	516,985	2,941,750	3,458,735
Magnesium...	72,800	448,140	520,940
Chlorine......	114,370	173,790	288,160
Zinc..........	169,100	58,736	227,836
Copper.......	55,230	0	55,230
Total...	928,485	3,622,416	4,550,901

If the cell-line voltage is 250 v., the rectifier equipment is competitive in first cost with rotating apparatus, when building cost, ventilation, and foundations are considered. Rectifier equipment is in the neighborhood of 50 to 55 dollars per d.c. kilowatt installed. Below 250 v., rotating apparatus is generally installed because the operating advantages of rectifiers cannot overcome the advantage of rotating apparatus in first cost and efficiency.

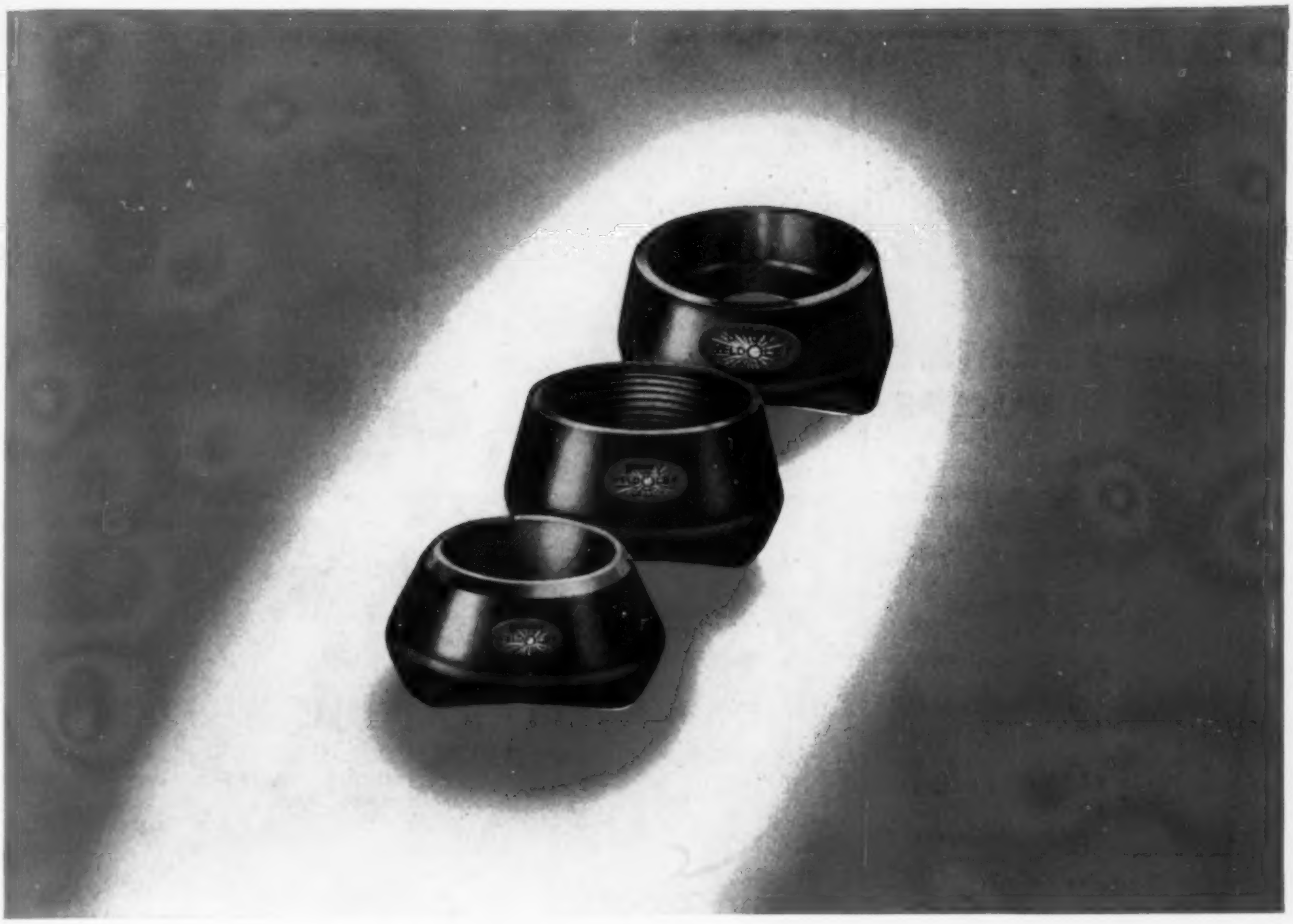
T. R. Rhea and B. R. Connell, General Electric Co., before the Electrochemical Society, Toronto, Oct. 17, 1946.

DIFFRACTION STUDIES OF TURBINE DEPOSITS

A STUDY of a number of steam turbine deposits using x-ray diffraction techniques as a means of identifying the crystalline phases present was made. The study has been limited to those compounds which may be the result of carry-over of material from the boiler.

With the exception of amorphous silica, compounds found in turbine deposits are normally well crystallized, indicating that the conditions surrounding their occurrence are favorable for grain growth.

Evidence was found of the tendency of sodium metasilicate, sodium disilicate,



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quartz, and amorphous silica to occur as a series in the order named with decreasing temperatures. Other components of turbine deposits, such as sodium chloride, fail to show a temperature relationship.

Some compounds such as sodium chloride, burkeite, and the sodium sulphates appear to be related to low-pressure operation. Acmite has so far been found associated with high-pressure operation. Other compounds such as sodium disilicate, quartz, and amorphous silica appear to have no relation with the operating pressure.

L. A. Burkardt and C. E. Imhoff, Allis-Chalmers Mfg. Co., before Division of Water, Sewage and Sanitation Chemistry, American Chemical Society, Chicago, Sept. 10, 1946.

VULCANIZATION OF GR-S WITH HALOGEN COMPOUNDS

An entirely new class of nonsulphur vulcanizing agents for butadiene-styrene copolymer rubbers has been discovered. This consists of halogenated compounds which may be divided into three types: (1) halogenated aliphatic hydrocarbons containing at least one $-CX_3$ group, where X represents chlorine, bromine, or iodine, (2) halogenated aryl methyl compounds containing at least one halogen in the methyl group, and (3) aliphatic compounds containing a $-CX_3$ group and another reactive group, such as ethyl trichloroacetate. Each of these types behaves somewhat differently with respect to activation by metal oxides and other substances, but all will give vulcanizates having high moduli and good tensiles. The vulcanizing agents of the second type are of particular interest since by their use vulcanizates of unusual aging properties can be produced. These vulcanizates show no increase in moduli or decrease in elongations on 1-2 day 100 deg. C. oven aging, and sometimes even show reversion on aging, which is a very unusual phenomenon for GR-S.

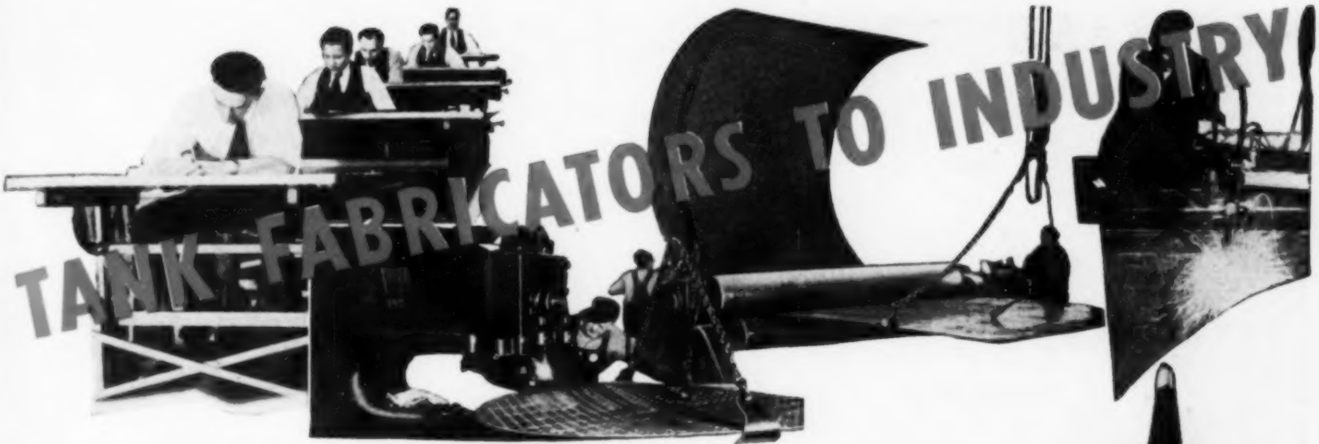
These halogenated vulcanizing agents may lead to new concepts of the vulcanization process.

B. M. Sturgis, A. A. Blum and J. H. Trepagnier, E. I. du Pont de Nemours & Co., before Division of Rubber Chemistry, American Chemical Society, Chicago, Sept. 11, 1946.

FOREIGN LITERATURE ABSTRACTS

SULPHATES IN DRINKING WATER

Sulphates in water are usually determined either gravimetrically as barium sulphate, or by Marty's method of successive approximations. There is also a volumetric method for the determination of soluble sulphates using a reagent with a barium chromate base which was applied to sodium sulphate by Goise. This complicated method has now been simplified and the blank test eliminated. The determination is carried out as follows: 200 cc. of water is measured into a 500 cc. Erlenmeyer flask. Approximately 2 g. of pulverized barium chromate is added and 2 cc. of pure hydro-



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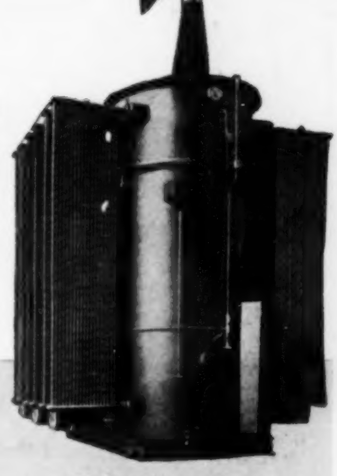

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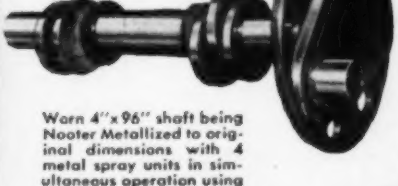

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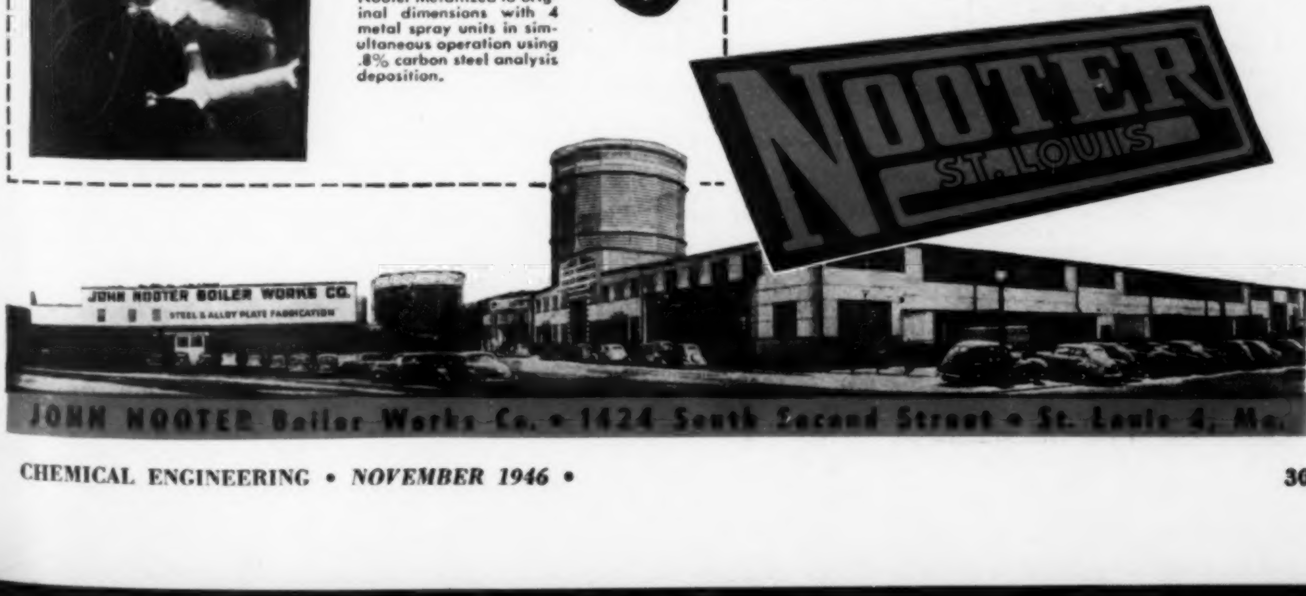

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chloric acid. The mixture is boiled for 2 min., and then ammonia is added until there is a definite odor. The mass is permitted to cool, placed in a calibrated 250 cc. glass tube and the distilled water used for washing out the Erlenmeyer flask several times, is added. The mixture is then filtered several times until a clear liquid is obtained, 125 cc. of this liquid is removed, and 1 g. of pure potassium iodide and 10 cc. of $\frac{1}{4}$ sulphuric acid is added. It is titrated with N/20 sodium hyposulphite in the presence of starch paste. N cc. are consumed; $N \times 0.00163$ = sulphates per liter of water expressed as sulphuric acid.

Digest from "Determination of Sulphates in Drinking Water" *Bull. Trav. Soc. Pharm. Bordeaux* 83, No. 1, 9-11, 1945. (Published in France); *Chimie et Industrie* 55, No. 4, 272, 1946.

MEXICAN PETROLEUM AND GAS

Mexico has fabulous quantities of gas which are being wasted and which could be an important base for chemical industries on a large scale. It has liquid hydrocarbons in the entire series of possible types, from the highly asphaltic petroleum to that having a paraffin base. This country's production has reached second place in the world, and only a small proportion of the potential sources has been exploited so far. For many years Mexico's petroleum has been under the control of international trusts, a situation which is very discouraging to the future development of this industry. If Mexico is to develop an important chemical industry based on liquid and gaseous hydrocarbons, it is essential that the government make it possible for private enterprise to develop in the country and discourage foreign control.

Digest from "National Chemical Industry" by Jose D. Lavin, *Quimica* IV, No. 2, 31-36, 1946. (Published in Mexico.)

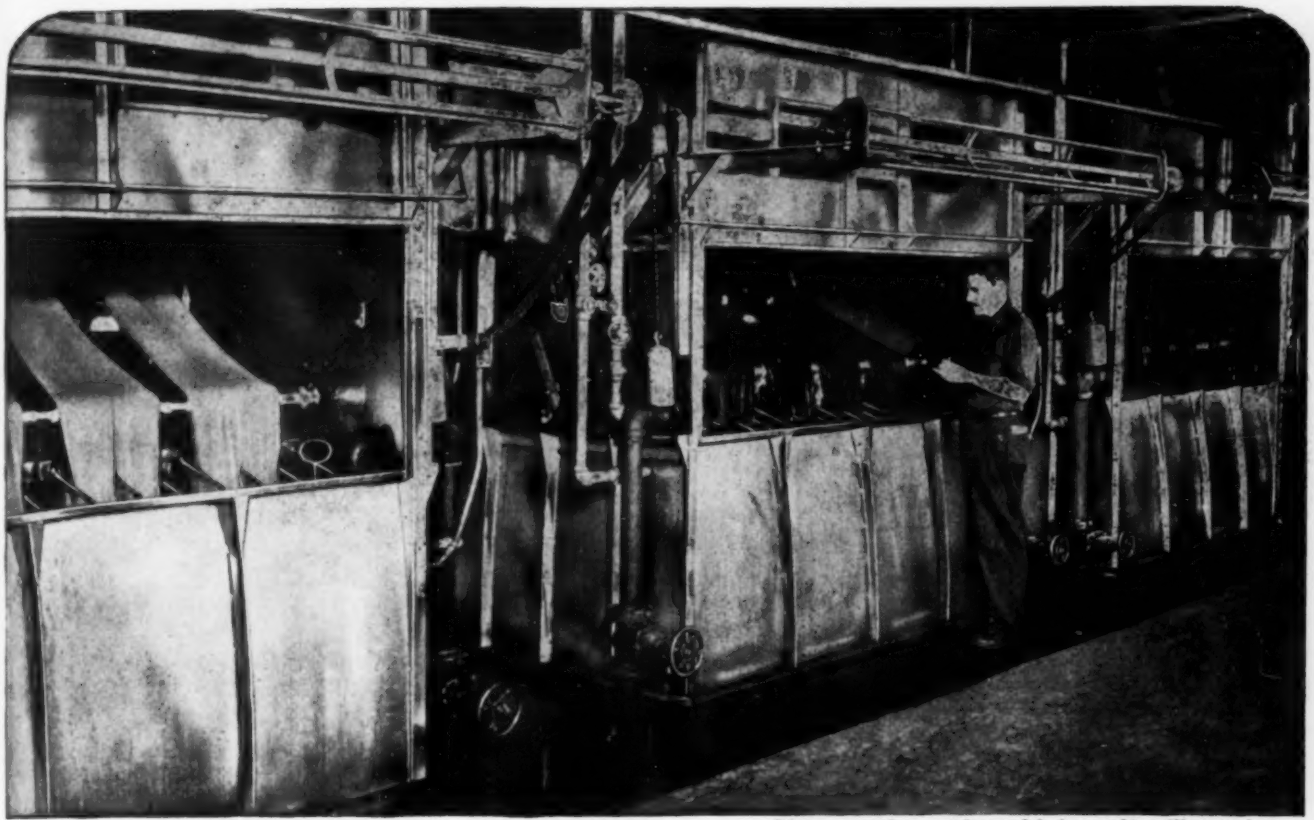
ARGENTINE CLAYS

Knowledge of the chemical composition of kaolins is important in their utilization, but it is also necessary to know the proportion of the accompanying materials to the aluminum hydrosilicate, content and type of sand, physical properties, etc. Samples were taken from the Maria Eugenia mine in Buenos Aires and the Mutouin mine in Catamarca. They were subjected to an elemental chemical analysis; a rational chemical analysis to separate the soluble silicic acid from the insoluble by means of sodium carbonate (the soluble part corresponds to aluminum hydrosilicate and the insoluble to quartz and feldspar); a physico-chemical analysis to determine the water-soluble salts which may harm the consistency of the finished material; a physical analysis to determine the quantities of coarse and fine sand, and its size, as well as the quanity of pulverulent clay capable of forming mud.

Digest from "Physico-Chemical Study of Argentine Clays", *Industria Minera* VI, No. 56, 69-70, 1946. (Published in Argentine.)

BIOTIN

Biotin, a compound which is widely distributed in nature, even if in very small quantities, is not only important as a stimulant for the growth of yeast and various



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microorganisms, but is also a phytohormone which affects the growth of higher plants. Nor is there any doubt that it is also essential to the health of higher animals and man. It occurs in the tissues of various organs, especially the liver and kidneys, and is a constant component of urine, blood serum, milk and many food products. Biotin is identical to the coenzyme "R," a factor of growth and respiration of Rizobia trifolii and with vitamin H. Biotin is extracted from such materials as yeast, egg yolk, liver, etc. by taking advantage of its capacity for adsorption on carbon, followed by extraction with an ammonia solution of acetone and other solvents. It was found that biotin and its methyl ether are equally active. In many cases desthiobiotin is just as active, but the diaminopelargonic acid made from it has only 10 percent of the activity of biotin. Alpha-biotin, beta-alanine, and hexylglyoxilidone show a biotin activity to a lesser degree.

Digest from "Biotin," by N. G. Yartseva, *Uspekha Khimii* XV, No. 2, 203-204, 1946. (Published in Russia.)

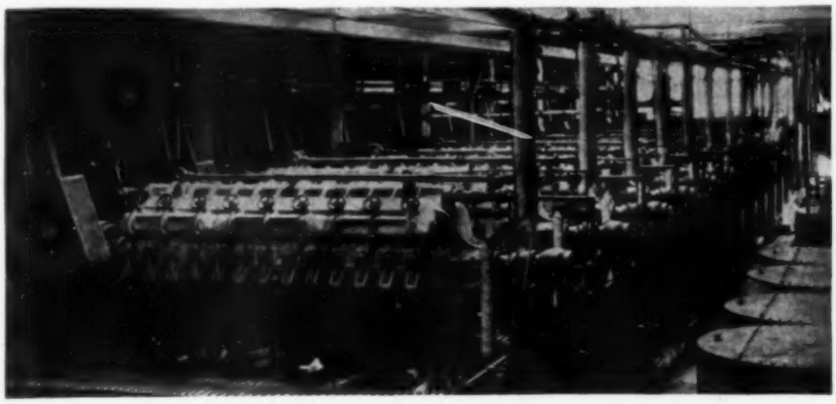
SULPHO-OXIDIZED SOAPS FROM PETROLEUM BYPRODUCTS

Residues from the manufacture of lubricating oils by cracking serve as raw material in the Van Andel process. These residues, which have not been utilized so far, are distilled and the 160-310 fraction contains a large proportion of olefins.. Suitable treatment with H_2SO_4 results in sulpho-oxidized soaps of a quality comparable to that of products now available on the market. Sulpho-oxidized soaps have the same colloidal properties as ordinary soaps, properties which influence their detergent power. If the latter soaps have a general formula of RCO_2Na (carboxylates), then the sulpho-oxidized soaps have the formula $R{\cdot}SO_3Na$ (sulphonates) or $R{\cdot}O{\cdot}SO_3Na$ (alkyl sulphates) or a mixed formula. Presence of the CO_2Na group gives the soaps properties similar to those of carbonates: precipitation by all the metallic salts except the alkalis; ready decomposition by the acids. The sulphonates and the alkyl sulphates, on the contrary, are soluble no matter what cation is bound to the functional group. As a result, they are not precipitated either by the salts of calcium or magnesium or by hard water nor are they decomposed either by acids or by sea water. Their solubility in water is much greater than that of ordinary soaps. The viscosity of their solutions is very low. All in all, their detergent and wetting power is definitely better. The sulpho-oxidized detergents produced by the Van Andel process are superior to all the other products—their aqueous solutions are still fluid at 35 percent, whereas the other sulphonates or alkyl sulphates cannot be used at more than 5 percent, and the soaps at more than 1 percent; their lime and magnesium salts are very soluble and sea water does not attack them. These are the best products for cleaning, laundering, bleaching and scouring in the textile and dyeing industry.

Digest from "Manufacture of Sulpho-Oxidized Soaps from Petroleum By-products. Van Andel Process." *Genie Civil*, 122, No. 4, 27-29, 1945. (Published in France); *Chimie et Industrie* 55, No. 5, 368, 1946.

CHEMICAL ENGINEER'S BOOKSHELF

LESTER B. POPE, Assistant Editor



Continuous pressure filters in a sugar plant

SOLIDS FROM LIQUIDS

THEORY AND PRACTICE OF FILTRATION. *By George D. Dickey and Charles L. Bryden. Reinhold Publishing Corp., New York.* 346 *pages.* $6.

ONE of the most widely used separation methods, filtration, is used in nearly every chemical processing plant. This book is primarily devoted to the separation of solids from liquids by the use of porous media. Generally, it can be divided into two parts, the first dealing with history, theory and principles as a foundation for the proper understanding and interpretation of filtration. The remaining part, and by far the bulk of the book, is devoted to the various types of filters, auxiliary equipment, and information concerning these.

Historically, the whole subject is treated from ancient times to the present. Early concepts, patents, and the various important developments are covered. Theory and principles are discussed in some detail and the contributions of various persons in this field are outlined. This is followed by a study of filtration objectives in which the major purposes are discussed and process variables such as rate of flow, temperature, concentration, etc., are shown in relation to the problem. Use of such materials as coagulants, precoats, filter aids, and adsorbents, is described. An excellent discussion of filter media, their characteristics and applications, helps provide a good basic knowledge of this most important element of filtration equipment.

Seven full chapters are used to describe the various major types such as gravity filters, pressure filters, vacuum filters, hydraulic pressure and squeeze presses, expellers, centrifugals, and auxiliary equipment. Depending on the particular type of equipment described the author has gone into sufficient detail so that the reader can evaluate a particular filter with respect to his own problems. In many cases the discussion of each filter is broken down into sections on construction, operation, materials handled, advantages, disadvantages, materials of construction, and sizes. Certain subjects, such as water filtration and sewage clarification, are considered by themselves. A number of typical applications are shown, and the subjects of testing and selecting filters as well as installation and operation are treated.

A large number of illustrations including photographs, cutaway views, diagrammatic sketches and flowsheets are used to illustrate principles, equipment, applications, and installations. On the whole, the book presents a comprehensive review of the subject of filtration and is a book that can be used to practical advantage by engineers.

AVENUE OF APPROACH

VAPOR ADSORPTION. *By Edward Ledoux. Chemical Publishing Co., Brooklyn.* 360 *pages.* $8.50.

Reviewed by E. R. McLaughlin

VAPOR adsorption, a laboratory phenomenon which has grown to be a vital adjunct in industry, is still somewhat of a mystery. Present methods are limited to operating experience. There is a definite need for a guide to aid those making their initial survey of adsorption theories and methods. The author's preface outlines a text which might fill this need. However, the subsequent treatment given to each subdivision of the subject is rather superficial, as it must necessarily be to be included in a small volume. The various principles are given and numerous theories are summarized with examples to substantiate some of them. Nearly a third of the book is devoted to static adsorption. An understanding of static adsorption provides essential fundamentals, but the industrial application of vapor adsorption is seldom static.

The second part of the book is a hasty recapitulation of psychrometry, heat transfer, and vapor transfer as a build up to the problem of dynamic adsorption.

Only twelve pages each are devoted to dynamic adsorption, and to dynamic desorption. For comparison, dehumidification by refrigeration is discussed for several pages, and absorption, which is an entirely different phenomenon, rates twelve pages. Industrial applications include air conditioning, conditioning underground spaces, hygroscopic materials, compressed gases, and vapor recovery.

A book of this nature cannot possibly contain all of the known information on adsorption. The operating engineer will find no trade secrets. However, the treatment offers an avenue of approach to the subject for the student exploring the field for the first time.

COLLOID PRIMER

COLLOIDS, THEIR PROPERTIES AND APPLICATIONS. *By A. G. Ward. Interscience Publishers, New York.* 133 *pages.* $1.75.

Reviewed by F. C. Nachod

THIS little booklet is indeed a fine primer of colloid science. It is subdivided into three main parts: the nature of the colloidal state, the colloidal systems, and colloids in industry and in living matter. In this last part, various industries in which colloid chemistry plays an important role, such as rubber, cellulose, proteins, clays, paints, lacquers, varnishes, detergents are dealt with briefly and in a descriptive manner. A bibliography refers the reader elementary and advanced texts.

It is to be hoped that other members

RECENT BOOKS RECEIVED

Atomic Theory for Students of Metallurgy. By W. Hume-Rothery. Institute of Metals, London. 7s. 6d.

Chemical Analysis of Metals. American Society for Testing Materials. $4.50.

The Chemistry of Heterocyclic Compounds. By A. A. Morton. McGraw-Hill. $6.

Fuels, Combustion and Furnaces. By J. Griswold. McGraw-Hill. $5.50.

Incendiary Warfare. By G. J. B. Fisher. McGraw-Hill. $3.

Introduction to the Chemistry of the Silicones. E. G. Rochow. Wiley. $2.75.

Oil Field Development. 3rd ed. By L. C. Uren. McGraw-Hill. $7.

Personal Adjustment. By K. Dunlap. McGraw-Hill. $4.

Statistical Quality Control. By E. L. Grant. McGraw-Hill. $5.

What Industry Owes to Chemical Science. Chemical. $5.

When the Oil Wells Run Dry. By W. M. Fuchs. Industrial Research Service. $3.75.

of Blackie's "Technique" series, where Mr. Ward's colloid chemistry text made its first appearance in England, will be made available in this country.

SUPPLEMENTARY READING

GERMAN FOR THE SCIENTIST. *By Peter F. Wiener. Chemical Publishing Co., Brooklyn. 238 pages. $3.50.*

Reviewed by M. G. Callaham

THIS new scientific reader includes approximately 40 pages of grammar, 52 pages of chemistry passages and 31 pages of physics passages. The rest of the book is devoted to a translation of these passages and a vocabulary. This book should provide good supplementary reading for Fotos and Shreve's "Advanced Readings in Chemical and Technical German."

RUSSIAN ENIGMA

TWO WORLDS. *By William B. Ziff. Harper & Brothers, New York and London. 335 pages. $3.*

Reviewed by H. C. Parmelee

THE meeting of the Assembly of the United Nations Organization in New York is a perfect background for reading this book, with Russia alternately frightening the delegates with Mr. Molotov's disquieting speeches, and then reassuring them with Mr. Stalin's disarming answers to United Press questions. The rest of the world can hardly be blamed if, at one minute it looks around apprehensively for the cyclone cellar, and then wonders if it can believe its ears at sounds of peace and harmony. But all this emphasizes the enigma of Russia in international relations, particularly with the U.S.A. which, Mr. Ziff believes, must take drastic measures to survive the tide of Communism now flowing over the world. Don't read this book if you dislike facing unpleasant realities and prefer to spend your evenings quietly in the comfort and security of your home. On the other hand, it may be just as well to get the basic idea that, although Russia may from time to time change its tactics, it never changes its strategy for the conquest of the world for the proletariat. This goal is just as explicit in the writings and speeches of Stalin and other Russians, as was Hitler's in *Mein Kampf*. Anyhow, you can't say Mr. Ziff didn't warn you.

The author has a style and vocabulary that sets a swift pace, giving the impression that time is short, and that maybe it is already too late to set up the two worlds he envisages—one dominated by the U.S.S.R. and the other by the U.S.A. But he documents his contentions with historical facts and figures that seem inescapable, laying bare the "jungle of international diplomacy," the ultimate resort to power politics that undermine efforts at collaboration, and the violation of agreements like those reached at Yalta, Teheran, Moscow, and Potsdam.

Discarding the United Nations Organization as an ineffective instrumentality for world peace—not much better than the old League of Nations—the author sees nothing but war in pursuing the present policies of the U.S.S.R. and the U.S.A. Their philosophies, ideologies, historical

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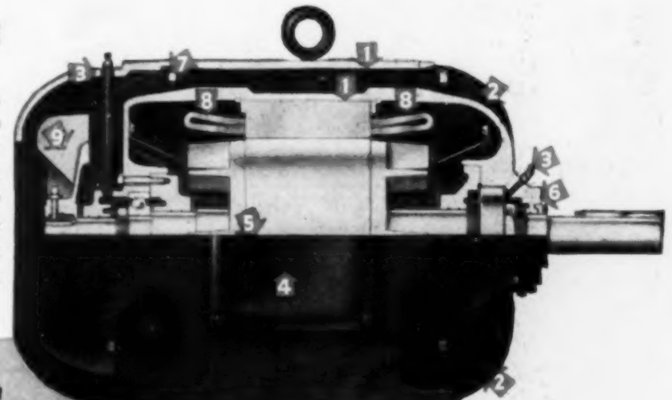

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GENERAL ELECTRIC

background and culture are mutually exclusive and offer no promise of a permanent alliance. But he regards these two nations—each a Federation of States—as natural nuclei for the formation of two World Federations that can be self sustaining and sufficiently strong to resist aggression. These are his "Two Worlds," composed of central powers and their adhering states, one in the West and one in the East. Patterning the former on the latter, "The union we should seek to achieve should reach from Pole to Pole, and from Dover, England, to Perth, Australia. It should embrace all territories on which a human being can subsist in either the Atlantic or Caribbean oceans; and in the Pacific up to the very doors of Japan." In the author's opinion the clock of destiny is now striking and giving the U.S.A. its great opportunity to create a free world fit for free men to live in.

FIFTH REVISION

PHYSICAL CHEMISTRY FOR COLLEGES. *Sixth edition, By E. B. Millard. McGraw-Hill* Book Co., New York. 682 pages. $4.50.

TWENTY-FIVE years is a long time for a textbook to remain current in a field which is advancing as rapidly as that of physical chemistry. But such is the case with Millard's which had its first copyright in 1921. And the new revision has modernized the text to give new crops of students the benefit of latest theories and discoveries. Much of the text has been rewritten and new problems have been added. Selection and order of topics has been retained but some shifting of emphasis is apparent.

RECENT BOOKS and PAMPHLETS

Chemical Engineering as a Profession. By W. T. Read. Vocational Booklet No. 3, National Roster of Scientific and Specialized Personnel. Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 21 pages. 10 cents. The field, growth and outlook of the profession; the work of the engineer; where employed; qualifications; conditions of employment; how careers are started.

Chemistry as a Profession. By W. T. Read. Vocational Booklet No. 2, National Roster of Scientific and Specialized Personnel. Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 20 pages. 10 cents. Data given for chemistry under the same headings as for Chemical Engineering as a Profession.

Potential Hazards in Molten Salt Baths for Heat Treatment of Metals. Published by National Board of Fire Underwriters, 85 John St., New York 7, N. Y. 40 pages. Contributory factors responsible for many incidents encountered. Suggested workable requirements and regulations safeguarding nitrate baths.

The Metallurgy of Quality Steels. By Charles M. Parker. Published by Reinhold Publishing Corp., 330 West 42nd St., New York 18, N. Y. 248 pages. $6. Manufacturing methods, inspection, testing, effects of alloys, hardening.

Rubber Statistical Bulletin. Published by London Rubber Secretariat. Distributed by India Rubber World, 386 Fourth Ave., New York. Annual subscription, $5. Vol. 1, No. 1 of a new monthly publication issued by an organization set up by the Governments of the United Kingdom, France and the Netherlands to collect and collate statistical and other general information on rubber.

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WELDCO — *Specialists in Corrosion Resistance*

By C. B. Willingham and F. D. Rossini. Research Paper RP1724 National Bureau of Standards. Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. .C 29 pages. 10 cents. Assembly, testing and operation of columns used in the Bureau in the work of API research project 6 (analysis and purification of hydrocarbons) and in the preparation of standard samples.

Bacterial Chemistry and Physiology. By J. R. Porter. Published by John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. 1,071 pages. $12. Graduate and undergraduate textbook as well as for reference use.

Application of Shaped Explosive Charges to Mining Operations: Tests on Steel and Rock. By R. S. Lewis and G. B. Clark. Bulletin No. 1, published by Department of Mining Engineering, University of Utah, Salt Lake City. 48 pages. $1.25. Shaped charges have a definite and useful application in mining operations both in secondary rock breakage and drilling holes for blasting solid faces of rock. Includes a brief history of the Munroe effect which made bazookas possible.

Finishing Metal Products. Second edition. By H. R. Simonds and A. Bregman. Published by McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. 352 pages. $4. Techniques involved, commercial aspects, sales value, economics, equipment, part design, and metal finishing costs.

Communist Infiltration in the United States. Published by Chamber of Commerce of the United States, Washington 6, D. C. 40 pages. 10 cents. Nature of communism and how to combat it.

Extractives From Northeastern Woods. Bulletin No. 9, published by Northeastern Wood Utilization Council, 839 Chapel St., New Haven, Conn. 62 pages. $1. Commercial production in the Northeast, economic extraction of essential oils, and a literature review.

Safety, Sanity, and Survival. By W. J. Wiswesser, director of chemical research, Willson Products, Inc., Reading, Pa. 2 pages. Mimeographed sheet which stresses the fact that everyone loses in radioactive and biological warfare. Gives three steps toward "Universal Safety."

Standard Metal Directory. 1946 edition. Published by Atlas Publishing Co., 425 W. 25th St., New York 1, N. Y. 842 pages. $10. Plants, foundries, mills, manufacturers, distributors, fabricators, etc.—a reference book for the steel and metal industries.

Trane Air Conditioning Manual. Published by the Trane Co., La Crosse, Wis. 376 pages. $5. New edition.

1946 Classified Directory. Published by Association of Consulting Chemists and Chemical Engineers, 50 East 41st St., New York 17, N. Y. 98 pages. Tenth edition of the listing of qualifications of 88 member concerns of the Association.

A Quick Look at Portland. Published by Industries Dept., Portland Chamber of Commerce, 824 S. W. Fifth Ave., Portland 4, Ore. 8 pages. A short study of natural resources, power, transportation facilities, labor and industry, taxes, and culture in the Portland area.

New Factories for California Communities. Pamphlet 11, published by State Reconstruction and Reemployment Commission, Sacramento, Calif. 21 pages. Prepared by J. N. Mills & Co. Shows how certain small California communities have provided facilities for factories and thereby induced firms to establish plants in this State.

Economic Base for Power Markets in Ferry, Stevens, and Pend Oreille Counties, Wash. By Peter Palmer. Published by Bonneville Power Administration, Portland 8, Ore. 47 pages. A survey appraising prospects for electric power consumption in these counties. Reviews the physical base, people and their incomes, public facilities and finance. Maps, photographs, and appendix tables are included.

Tungsten Deposits of Osgood Range, Humbolt Co., Nevada. By S. W. Hobbs and S. E. Clabaugh. Bulletin 40, published by Nevada Bureau of Mines and Mackay School of Mines, University of Nevada, Reno, Nev. 50 cents. Includes 11 maps of properties of the Getchell district with descriptions of properties and estimates of ore reserves.

Industrial Raw Materials for Portland-Vancouver Area. Prepared by Industries Dept., Portland Chamber of Commerce, 824 S. W. Fifth Avenue., Portland 4, Ore. 8 pages. Availability, quality, and economics of limestone, industrial carbon, ferruginous bauxites, gypsum, salines, silica and other chemical and industrial raw materials of the area.

GOVERNMENT PUBLICATIONS

The following recently issued publications are available at prices indicated from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. In ordering any publications noted in this list always give complete title and the issuing office. Remittances should be made by postal money order, coupons or check. Do not send postage stamps. All publications are in paper cover unless otherwise specified. When no price is indicated, the pamphlet is free and should be ordered from the bureau responsible for its issue.

Fifth Annual Report of Special Committee Investigating the National Defense Program (formerly Truman Committee, later Mead Committee, now Kilgore Committee). Senate Report No. 110, Part 7. Price 25 cents.

Industrial Classification Manual. Bureau of the Budget. Volume 1, Manufacturing Industries. Part 1, Titles and Descriptions of Industries. Price 75 cents. Part 2, Alphabetic Index. Price $1.

Committee on Food Research—Research Program 1945-1946. Quartermaster Corps Manual QMC 17-8. Available free on request to Quartermaster Food and Container Institute, 1849 West Pershing Road, Chicago 9, Illinois.

Statistics and Maps for National Market Analysis (Basic Information Sources). Department of Commerce, Inquiry Reference Section. Unnumbered, mimeographed, September 1946.

Synthetic Organic Chemicals, United States Production and Sales, 1944. Tariff Commission, Report No. 155, Second Series. Price 25 cents.

United States Import Duties, June 1946. 1. Titles I and II of the Tariff Act of 1930 (Dutiable and Free Lists). 2. Changes in Import Duties since 1930 (Prepared by the U. S. Tariff Commission). Department of State Publication 2540, Commercial Policy Series 87. Price 70 cents. Also flat-opening, plastic-ring-binder type, price $1.25.

Suggested Charter for an International Trade Organization of the United Nations. Department of State Publication 2598. Commercial Policy Series 93.

Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1945-46. Department of Agriculture Miscellaneous Publication No. 603. Price 25 cents.

Rapid Photometric Methods for Determining Rubber and Resins in Guayule Tissue and Rubber in Crude-Rubber Products. By Hamilton P. Traub. Department of Agriculture Technical Bulletin 920. Price 10 cents.

Research on Peanuts and Peanut Products at the Southern Regional Research Laboratory. By K. S. Markley. Bureau of Agricultural and Industrial Chemistry, AIC-109. Mimeographed.

Glutamic Acid Review and Bibliography. By H. S. Olcott and G. H. Brother. Bureau of Agricultural and Industrial Chemistry, AIC-119. Mimeographed.

Report of Studies on Uniformity of Quality of Beet Sugars. By C. A. Fort and others. Bureau of Agricultural and Industrial Chemistry, AIC-123. Mimeographed.

A Power Sprayer for Applying Concentrated Insecticides. By Joseph N. Tenhet. Bureau of Entomology and Plant Quarantine, ET-231. Mimeographed.

A System of Filing and Routing Samples of Chemicals for Insecticide Testing. By M. W. Oberg, et al. Bureau of Entomology and Plant Quarantine, ET-233. Mimeographed.

The Use of DDT for Roach Control. By L. S. Henderson. Bureau of Entomology and Plant Quarantine, E-701. Mimeographed.

Field Studies on the Effect of DDT on Aquatic Insects. By C. H. Hoffman, et al.

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Bureau of Entomology and Plant Quarantine, E-702. Mimeographed.

Water Levels and Artesian Pressure in Observation Wells in the United States in 1943: Part 1. Northeastern States. By E. O. Meinzer and others. Geological Survey Water-Supply Paper 986. Price 50 cents.

Nickel Investigations in Southeastern Alaska. By George C. Kennedy and Matt S. Walton, Jr. Geological Survey Bulletin 947-C. Price 15 cents.

Copper Deposits of the Nizina District, Alaska. By Don J. Miller. Geological Survey Bulletin 947-F. Price 15 cents.

The German Steel Castings Industry. By Charles W. Briggs nd Maz T. Ganzuage. Bureau of Mines, Information Circular I. C. 7362. Mimeographed.

Perlite, Source of Synthetic Pumice. By Oliver C. Ralston. Bureau of Mines, Information Circular I. C. 7364. Mimeographed.

Safety Record of Mine No. 7, Island Creek Coal Co., Holden, Logan County, W. Va. By A. U. Miller and C. E. Linkous. Bureau of Mines, Information Circular I. C. 7365. Mimeographed.

Review of Fischer-Tropsch and Related Processes for Synthetic Liquid Fuel Production. By Norma R. Golumbic. Bureau of Mines, Information Circular I. C. 7366. Mimeographed.

Coal-Research Activities of the Bureau of Mines. By A. C. Fielder Bureau of Mines, Information Circular I. C. 7367. Mimeographed.

Mica and Beryl Examination and Exploration in Cleburne, Randolph, Clay, Coosa, Chilton, Tallapoosa, and Lee Counties, Ala. Bureau of Mines, Report of Investigations R. I. 3905. Mimeographed.

Concentration of Bauxite for Milling in the 50-Ton Bureau of Mines Pilot Plant. Bauxite, Ark. By S. M. Runke and R. G. O'Meara. Bureau of Mines, Report of Investigation R. I. 3909. Mimeographed.

Exploration of the New Dale Rundell Zinc Mine, Mifflin District, Iowa County, Wis. By Francis C. Lincoln. Bureau of Mines, Report of Investigations R. I. 3912. Mimeographed.

Exploration of Spirit Mountain Nickel Prospect, Canyon Creek, Lower Copper River Region, Alaska. By Harold C. Pierce. Bureau of Mines, Report of Investigations R. I. 3913. Mimeographed.

Exploration of the Copper Butte Mine, Mineral Creek Mining District, Pinal County, Ariz. By Harlow D. Phelps. Bureau of Mines, Report of Investigations R. I. 3914. Mimeographed.

Storage of Subbituminous Slack Coal in Open Pits. By John B. Goodman, et al, Bureau of Mines, Report of Investigations R. I. 3915. Mineographed.

Exploration of the Shanton Iron-Ore Property, Albany County, Wyo. By Eugene Frey. Bureau of Mines, Report of Investigations R. I. 3918. Mimeographed.

Magnetic Reconnaissance in North-Central Minnesota in 1945. By E. Y. Dougherty and E. F. Fitzhugh, Jr. Bureau of Mines. Report of Investigations R. I. 3919. Mineographed.

Control of Gelation in Extraction of Alumin from Lime-Soda-Clay Sinters. By Guy Ervin, Jr., et al. Bureau of Mines, Report of Investigations R. I. 3923. Mimeographed.

Sponge-Iron Experiments at Longview, Tex. By Whitman E. Brown. Bureau of Mines, Report of Investigations R. I. 3925. Mimeographed.

Exploration of Glass Buttes Mercury Deposit, Lake County, Oregon. By Glenn C. Reed. Bureau of Mines, Report of Investigations R. I. 3926. Mimeographed.

Exploration of the Mount Hope Mine, Eureka County, Nevada. By E. J. Matson. Bureau of Mines, Report of Investigations R. I. 3928. Mimeographed.

Preliminary Exploration of Bi-Metallic Molybdenum Deposit, Okanogan County, Washington. By R. H. Storch, Bureau of Mines. Report of Investigations R. I. 3932. Mimeographed.

Clark Fork Lead-Zinc District, Bonner County, Idaho. By S. H. Lorain. Bureau of Mines, Report of Investigations R. I. 3992 Mimeographed.

MANUFACTURERS' LATEST PUBLICATIONS

Chemical Engineering's Readers' Service, in cooperation with manufacturers, makes it possible for you to secure catalogs, bulletins, and other publications herein listed without cost or obligation (unless a price is specifically mentioned). Please check the items you wish to receive and fill out the coupon. Please send requests to Readers' Service, Chemical Engineering 330 W. 42nd St., New York 18, N. Y.

1

Autoclaves. Autoclave Engineers, Inc., Chicago, Ill.—Bulletin No. 5. 8-page illustrated booklet describing high pressure stainless steel valves and fittings, autoclaves for visual observation, high pressure reactors, and other high pressure equipment.

2

Ball Mills. Abbe Engineering Co., New York, N. Y.—Catalog No. 63. 24-page booklet describing and illustrating jar mills and jar rolling machines for pulverizing, grinding, dispersing mixing, compounding, blending and extracting. The various types of equipment are ellustrated and described. Sizes and capacities are given for each type of equipment. A list of products and materials that have been successfully ground or processed in the company's equipment is given. A section is devoted to the selection of grinding media.

3

Batch Cooking System. Selas Corp. of America, Philadelphia, Pa.—Bulletin No. 333-F. 12-page illustrated bulletin describing the Selas system for batch cooking. It includes sectional and schematic drawings, tables, operating principles, applications, characteristics and advantages of this company's developments in the field of batch cooking. Includes data and information on the various individual components.

4

Blowers. Roots Connersville Blower Corp., Connersville, Ind.—Bulletin 120-V-13 is an 8-page folder illustrating the centrifugal blowers and exhausters available for a wide range of applications.

5

Cable Clamps. National Production Co., Detroit, Mich.—Folder illustrating and describing space-line wire rope clamps.

6

Catalyst. American Cyanamid Co., New York, N. Y.—8-page booklet describing the new Microspheroidal synthetic fluid cracking catalyst made by this company. Includes information on chemical characteristics, particle size control, activity, and applications.

7

Catalytic Cracking. M. W. Kellogg Co., New York, N. Y.—16-page illustrated brochure featuring the fluid catalytic cracking process. Contains a straightforward description of process operation illustrated by a multi-colored flow chart. Some design problems are discussed in detail. Several tables show a comparison of yield from various crudes.

8

Chemicals. Armour & Co., Chicago, Ill.—4-page booklet entitled "The Arneels as Plasticizers", discusses the use of aliphatic nitriles as plasticizers for certain synthetic rubbers, resins, etc. Contains a table of properties of the different types of Arneels.

9

Chemicals. Carbide & Carbon Chemical Corp., New York, N. Y.—A new edition of this company's book on emulsions contains 72 pages of complete information on chemical products in recently developed emulsion formulas. Contains over 113 suggested formulas and methods for emulsifying industrial oils, fats, waxes and greases.

10

Chemicals. Emery Industries, Inc., Cincinnati 2, Ohio—Section 2 of Emery Facts containing 7 pages which describe the chemistry and uses of fatty acids.

11

Chemicals. Mallinckrodt Chemical Works, St. Louis, Mo.—26-page booklet describing the metallic soap which gives the properties and uses of metallic stearate. Properties and industrial applications are discussed in some detail. Sections are devoted to gelling action, lubricating, waterproofing and water repellling, flatting action, covering powder and miscellaneous applications.

12

Chemicals. Philadelphia Quartz Co., Philadelphia, Pa.—4-page pocket size leaflet describes the use of potassium silicate as a paint vehicle, a binder in flux coating for welding rods, detergents and catalysts.

13

Chemical Stoneware. General Ceramics & Steatite Corp., Keasbey, N. J.—Bulletin CHE-R1 is a catalog of chemical stone ware equipment such as towers, pumps, agitators and kettles, storage vessels, pipes and fittings. Vari-

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ous types of equipment are illustrated and sizes and dimensions are given.

14

Color Conditioning. E. I. duPont de Nemours & Co., Finishing Division, Wilmington, Del.—32-page illustrated booklet featuring industry color conditioning. Illustrates and describes research and experiments with color to increase production, improve seeing conditions and creating a better working environment. Safety color code for industry is outlined.

15

Combustion. The Bryant Heater Co., Cleveland, Ohio—First ten of a series of data sheets prepared for combustion and process engineers includes mathematical tables, properties of gases, metals and other materials, and gas orifice capacity tables. Available in notebook punched sheets.

16

Concentrator. The Humphreys Investment Co., Denver, Colo.—Bulletin 5. 8-page bulletin describes the Humphreys spiral concentrator used for concentration of minerals. Principles of operation are discussed and many details are included such as operating costs, pilot plant testing, closed circuit ore testing. Contains several photographs and sketches to illustrate industrial applications and operating principles.

17

Concrete Shrinkage. The Master Builders Company, Cleveland, Ohio—34 page booklet entitled "The Action of Embeco in Concrete and Mortar." This booklet explains the principle of specially prepared metallic aggregate in controlling shrinkage. Contains charts, graphs and useful technical data. Discusses the general theory of shrinkage, factors affecting shrinkage, flocculation or dispersion of the cement, and other similar information.

18

Corrosion Inhibitor. J. K. Harbinson & Co., Buffalo, N. Y.—6-page pocket-size leaflet describing Masters metallic compound for use as a lubricant, rust and corrosion inhibitor, and seal. It is used to prevent destructive bonding of pipe threads and to efficiently seal and lubricate flanges and threaded joints. A number of applications are listed for this compound which is claimed to provide a tight seal at all joints working under pressures up to 600 lb. per sq. in. and temperatures up to 625 deg. F.

19

Dissolvers. The Cowles Co., Cayuga, N. Y.—4-page illustrated folder describing the dissolver made by this company. Standard, stationary and portable types are available, each adjusted to the viscosity, gravity and special characteristics of the materials to be handled. Principle of operation is described and illustrated.

20

Dust Collectors. The Aerotec Co. and Thermix Engineering Co., Greenwich, Conn.—Bulletin 310 illustrates and describes the integral dust collector made by this company. Details of this collector are described and illustrated.

21

Electric Motors. The Louis Allis Co., Milwaukee, Wis.—Bulletin No. 720. 12-page booklet illustrating and describing the Type OG standard squirrel cage induction motor made by this company. Features of this motor are shown by cutaway views and photographs and are described in detail.

22

Electric Motors. Electric Machinery Mfg. Co., Minneapolis, Minn.—20-page booklet entitled "The ABC of Synchronous Motor Control." Contains a large number of diagrams and photographs to illustrate the various principles of operation.

23

Electric Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—12-page engineering bulletin describing remote indicating and control systems. A number of applications in various process industries are discussed briefly.

24

Electric Equipment. Century Electric Co., St. Louis, Mo.—Form 646. 8-page booklet featuring alternating and direct current generators and motor generator sets, made by this company.

25

Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—16 page booklet designed for student training entitled "The ABC of Turbo Blowers, Rotary Compressors and Vacuum Pumps." The booklet is well illustrated showing simple construction of the turbo blower. Various curves are included for depicting pressure volume, influence of water vapor on

volume and correction curves for volume to maintain constant air weight with changes in temperature and barometric pressure.

26

Equipment. Henry Vogt Machine Co., Louisville, Ky.—14-page booklet illustrating a number of applications of the Class VL bent tube boiler made by this company. Details of construction and installation are shown in diagrammatic sketches.

27

Expansion Joints. Cook Electric Co., Chicago, Ill. — 12 page illustrated bulletin describing MagniLastic standard packless expansion joints, anchor joints and low pressure large diameter expansion joints. Lists complete engineering data, dimensional tables and specifications and contains information on offsets, turbo and jacket joints as well as high temperature exhaust bellows and other similar equipment.

28

Filter Aids. The Dicalite Co., Los Angeles, Calif.—Bulletin No. B-11. 16-page booklet describing industrial filtration with Dicalite filter aids. Principle of filtration using filter aids is discussed in detail. Photomicrographs illustrate the types of diatoms found in Dicalite filter aids. A typical filter system using this material is shown in schematic form. A number of applications are listed. Bulletin S-51 describes the use of filter aids in the manufacture of paper products.

29

Filters. Davis Filtration Equipment Co., Inc., New York, N. Y.—8-page booklet illustrating and describing the Clearflow "200" filters made by this company. Includes information on operation, construction features, capacities. Various applications are illustrated by schematic diagrams.

30

Fire Protection. American-LaFrance-Foamite Corp., Elmira, N. Y.—10-page booklet illustrating and describing the all-weather, water repellant, mildew resisting fire hose made by this company. The manufacture of this hose is illustrated and described.

31

Fire Protection. Cardox Corp., Chicago, Ill.—8-page booklet illustrating and describing the fire extinguishing systems and equipment available from this company.

32

Fire Protection. The Mearl Corp., New York, N. Y.—4-page leaflet describing Mearlfoam-5, how it performs, and its applications. This material is a liquid mechanical foam compound which when mixed with water and air in proper proportions produces fire extinguishing foam.

33

Fire Protection. Randolph Laboratories, Inc., Chicago, Ill.—20-page booklet entitled "How to Fight Fires and Protect Property" includes information on types of fire hazards and graphically explains the various techniques in fighting fires with carbon dioxide and other fire extinguishers. Includes information on the improved methods of operation for carbon dioxide, soda-acid, foam, pump tank and carbon tetrachloride extinguishers.

34

Furnaces. Eclipse Fuel Engineering Co., Rockford, Ill.—Bulletin D-9. 8-page booklet illustrating and describing the Eclipse Rotair airdraw furnace for use in heat treating at temperatures below 1250 deg. F. Operation details, construction details, and outstanding features of this equipment are described. Operating data is given in tabular form as well as sizes and specifications. A cutaway view illustrates the principles of operation.

35

Glass Apparatus. Scientific Glass Apparatus Co. Inc., Bloomfield, N. J.—8-page booklet illustrating and describing glass heating jackets constructed of fiberglass and fiberglass wool for use in laboratory work.

36

Glass Products. Oklahoma Planning & Resources Board, Oklahoma City, Okla.—26-page brochure outlining the advantages of locating glass manufacturing plants in the State of Oklahoma. Contains a graphic presentation which shows location of present glass plants, location of raw materials, fuel resources, power supply, transportation, population, labor, and markets.

37

Heat Exchangers. The Patterson-Kelley Co., Inc., East Stroudsburg, Pa.—12-page booklet illustrates and describes Freon water coolers for air conditioning and refrigeration equipment. Dry expansion water coolers using Freon are discussed and standard construction specif-

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cations are given. Includes diagrammatic layouts and sketches of the piping and control arrangement of this cooler in various applications. Detailed instructions for selecting the right size of water cooler are given and a 2-page cooler selection data chart in color is shown. Pertinent engineering data is given in tabular form.

38

Heat Treating. The Drever Co., Philadelphia, Pa.—2-page leaflet illustrating and describing the heat treatment of electrical steels by use of special atmospheres. Contains illustrations of ammonia dissociators.

39

Heaters. D. J. Murray Mfg. Co., Wausau, Wis.—12-page illustrated booklet gives details and capacity tables on the different models of grid unit heaters with high test cast iron heating sections. Features of design and construction are described.

40

Hydraulic Cylinders. Miller Motor Co., Chicago, Ill.—Volume 1, No. 1, a new house organ entitled "Hyd-Air" has been issued by this company. Contains technical items of interest to the hydraulic and air engineer, designer, manufacturer, and user.

41

Instruments. W. C. Dillon & Co., Inc., Chicago, Ill.—Booklet entitled "The Dillon Dynamometer Manual" gives information on the traction type dynamometer used in the simplification of testing and weighing procedures in many industries.

42

Instruments. General Electric Co., Schenectady, N. Y.—Bulletin GEA-4572. 8-page bulletin describes and illustrates the Type CF-2 inkless temperature recorder. Various industrial applications for this new unit such as recording temperatures in generators, transformers, ovens, air ducts, etc., are listed, along with complete specifications. Accessories are illustrated and described.

43

Instruments. Gotham Instrument Co., Inc., New York, N. Y.—Catalog No. G12. 8-page illustrated catalog covering this company's line of pressure gages. Complete listing of illustrations of various types of indicating gages includes data on structural features, together with tables of dimensions. The first issue of a new house organ entitled "The Gotham Bulletin" has also been issued.

44

Instruments. Mason-Neilan Regulator Co., Boston, Mass.—Catalog No. 301. 44-page catalog describing the control valves made by this company. Sections cover valve flow characteristics, selection, types of control valves, construction, specifications. Mechanical designs, operation of these control valves, are described and illustrated. Dimensions, weights, materials of construction and other specifications are included.

45

Instruments. McAlear Mfg. Co., Chicago, Ill —Bulletin No. 105 is a 28-page booklet featuring the various types of diaphragm motor valves manufactured by this company. Cutaway views are used to illustrate the various parts of the valve. Design features, construction, trim and other details are discussed. The various types of construction available are shown and a section is devoted to inner valve design and selection. Dimensional charts for the various types of valves are included. Prices are listed in a supplement section of the bulletin.

46

Instruments. Northern Equipment Co., Erie, Pa.—Bulletin 463. A 16-page booklet describing boiler feed control installations in various types of plants.

47

Instruments. Pittsburgh Equitable Meter Division, Rockwell Mfg. Co., Pittsburgh, Pa.—Bulletin 1136. 12-page booklet illustrating and describing gas appliance regulators with pressure cast aluminum alloy cases. Features of this regulator are illustrated schematically and some applications are described.

48

Instruments. Thwing-Albert Instrument Co., Philadelphia, Pa.—6-page booklet illustrating and describing the Currier size tester for use in evaluating the sizing in paper.

49

Instruments. Transicoil Corp., New York, N. Y.—2-page leaflet illustrating and describing the Transicoil 60 cycle, 2 phase, low inertia Servo-Motor for remote control applications.

50

Insulated Tile Conduit. Ric-Wil Co., Cleve-

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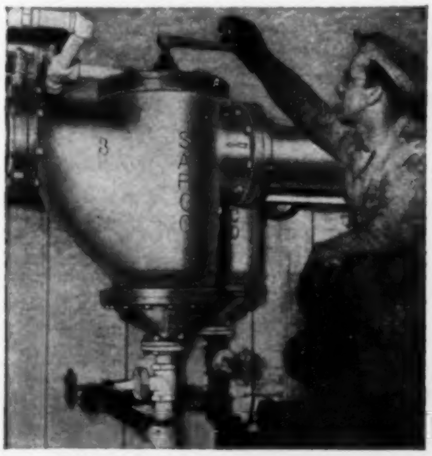
In many plants there is a flow of liquid—hot or cold—right in the production line. For years industry endured daily and hourly stoppages to clean out the lines—and rejects due to foreign materials were taken as a matter of course.

Now, with the Sarco Scraper Strainer, a few turns by hand—or motor—clear the strainer and the work goes on. In your plant, it may be syrup, varnish, fruit juices, oil or plain river water—the results are the same.

No messy basket to be lifted out and cleaned. No exposure of the liquid to airborne contamination and no lost time.

Sarco Scraper Strainers are available in sizes from ¾ to 8" and 200 lbs. Hand or motor operated. Also a complete line of standard strainers for steam and liquid lines. Ask for Catalogs Nos. 1200 and 1225.



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This pair of Sarco 8" Scraper Strainers made unnecessary the all-day job of cleaning unit heaters and main lines.

135

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land, Ohio.—10-page pamphlet describing the installation of underground steam conduits used by municipal power systems to serve steam to industrial plants. It is well illustrated with photographs and blueprints and contains figures and other technical data.

51

Insulation. Industrial Mineral Wool Institute, New York, N. Y.—20-page booklet discussing the use of mineral wool for various insulation applications. Contains information on selection of insulating materials for high temperatures, and illustrates the various forms in which mineral wool can be used. Contains several typical case histories illustrating how mineral wool insulation is used in various industrial applications. Actual savings of money resulting from this insulation installation are shown.

52

Materials Handling. Lisbon Hoist & Crane Co., Lisbon, Ohio.—8-page folder illustrating and describing this company's line of electric cable hoists. Outstanding features are given and cutaway views show the various parts.

53

Materials Handling. Automatic Transportation Co., Chicago, Ill.—8-page folder featuring the Transtacker. Explains and illustrates this high lift tiering unit. Sketches and photographs show the operation and construction of the various models. Contains dimensional specifications, weights and load capacities.

54

Pumps. Chicago Pump Co., Chicago, Ill.—Bulletin 190B. A 20-page catalog illustrating the Scru-Peller sludge pumps made by this company. The various types are illustrated by photographs. The principle of operation is described and specification data given. A number of applications are illustrated with diagrammatic sketches and performance curves shown. Also a 4-page folder illustrating and describing the company's gas mixing system for use in the chemical process industries.

55

Pumps. Economy Pumps, Inc., Hamilton, Ohio.—Catalog No. C746 contains 8 pages illustrating and describing the Type DMD, two stage pump made by this company. Details of construction are given, selection tables are shown, and cutaway views and photographs show some of the parts in detail.

56

Pumps. Peerless Pump Division, Food Machinery Corp., Los Angeles, Calif.—6-page leaflet describes the design, construction and application of three types of Peerless vertical centrifugal pumps for general purpose pumping in a variety of industrial services such as sump and drainage pumping, general water supply, mine station service, cooling tower service, etc. Sectional drawings show the various parts.

57

Pumps. Portable Pump Co., St. Louis, Mo.—Data sheets illustrating and describing the small capacity, self priming, centrifugal portable pump made by this company. It is used in such service as unloading carboys, unloading drums, underground storage tanks, and in various continuous processes. A list of corrosive solutions which may be handled by this stainless steel pump is given. Details of the pump are given in a dimentional sketch.

58

Pumps. Warren Steam Pump Co., Warren, Mass.—Bulletin 241. 6-page booklet illustrating and describing the 4- and 6-stage Type TM. pump made by this company. Details of construction are shown in cutaway views, and the metal specifications for the various parts are tabulated. It is designed for boiler feed and other high-pressure services.

59

Process Equipment. Industrial Process Engineers, West New York, N. J.—8-page booklet describing the services available from this company as well as processing equipment manufactured. Kettles, stills, autoclaves, mixers and auxiliary equipment are illustrated.

60

Proportioning Equipment. Proportioneers, Inc., Providence, R. I.—Bulletin 1,200. 28-page booklet illustrates and describes the automatic proportioning equipment for continuous treating, sampling, blending, and diluting in process operations. Diagrammatic sketches are used to illustrate these applications. Selection tables are given for the various equipments and specifications are included.

61

Recovery System. The Babcock & Wilcox Co., New York, N. Y.—16-page booklet entitled "Recovery of Chemicals and Heat in the Alkaline Pulping Industry" describes and illustrates the B&W Tomlinson recovery unit.

CHEMICAL ECONOMICS

H. M. BATTERS, Market Editor

PRODUCTION AND CONSUMPTION OF CHEMICALS PROMISE TO MAKE GOOD SHOWING IN FINAL QUARTER

While shortages of materials and problems in transportation remain as unfavorable factors, preliminary figures for industrial production so far this quarter, point to a heavy tonnage movement of chemicals. Steel mills made their best showing of the year in October and fertilizer mixers have been operating at a very high rate. Deliveries of explosives have been rising in volume and the increase in flat glass output is moving the industry totals to new highs. Production of chemicals has been affected appreciably by the transfer of government ammonia plants to the control of private companies. The shortage of raw materials is stressed in many industries yet at their convention held this month, the president of the National Paint, Varnish and Lacquer Association told the members that despite shortages of raw materials, paint production is higher than ever before. Plastics manufacturers complain about shortages yet figures show that plastics production is increasing steadily. Hence shortages exist because consuming demand has risen faster than the facilities to meet the demand. On the other hand shortages have resulted in some curtailment of outputs as lack of hides brought the closing of some tanneries in October. Production of soap in the third quarter dropped very sharply with sales of 494 million pounds the lowest since 1937 and nearly 25 percent below those for the corresponding 1945 quarter.

The preliminary index of *Chemical Engineering* places industrial consumption of chemicals in September at 205.38 compared with a revised figure of 212.54 in August. While the September figure shows a decline it resulted more from a drop in the number of working days than from any change in daily operating rates. The index numbers for August and September last year were 187.07 and 184.00 respectively.

Federal Reserve Board index for production of industrial chemicals in August has been revised to 398—the preliminary figure was 390—and September is placed at 403. Detailed production data for September show higher outputs for such basic chemicals as ammonia, calcium carbide, chlorine, electrolytic caustic soda, and sulphuric acid but a falling off commensurate with the reduced number of working days was noticed in the case of the majority of the other chemicals. The Board also reported a rise in all production with the September index as 182 and the revised August figure 179. In each case these numbers are the highest for the year to date.

Operations at vegetable oil crushing plants moved up in September with a consumption of 637,234 tons of oil-bearing materials compared with 585,035 tons for the preceding month. The rise was due largely to greater activities at cottonseed oil crushing establishments as new crop seed became available in larger volume. A material drop was reported in production of soybean oil. Refining plants operated pretty much in harmony with the crude oil pattern but more coconut oil was refined than in August even though crude production was lower. Trading in vegetable oils has been more active in recent weeks because price decontrols brought out larger offerings and the rising price trend failed to check buying interest.

The international food control body which recommends allocations of oils and fats that move in import and export trade emphasizes that supplies are short with requirements in excess of 4,600,000 long tons and available supplies less than 2,500,000 long tons. Final recommended allocation for the United States is 354,000 long tons, this including oils, fats and the oil equivalent of oil-bearing materials.

Chemical Engineering Index
Industrial Consumption of Chemicals

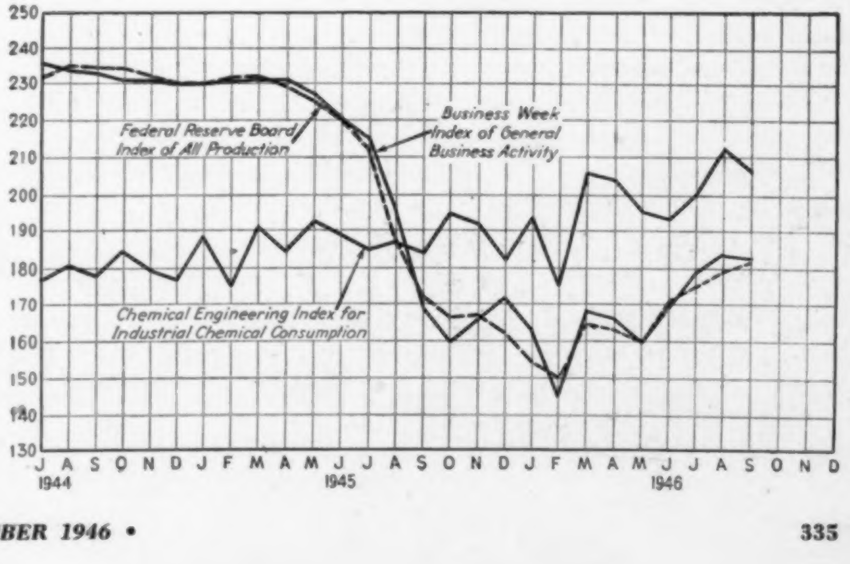
1935 = 100

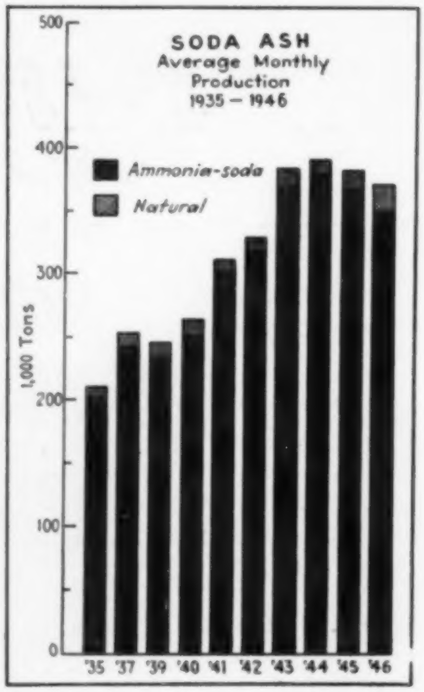
	Aug. Revised	Sept.
Fertilizers	44.94	46.30
Pulp and paper	22.80	20.65
Petroleum refining	19.71	18.98
Glass	23.95	22.70
Paint and varnish	22.27	20.46
Iron and steel	12.77	12.20
Rayon	20.10	18.93
Textiles	11.48	11.00
Coal products	9.73	9.35
Leather	4.70	4.30
Explosives	6.92	7.36
Rubber	6.90	6.65
Plastics	6.77	6.50
	212.54	205.38

Hope for improvement in the supply position of soda ash rests entirely on the installation of new productive capacity together with the renovation of some equipment now in use. Production of ash this year has been slowed because of strikes at producing plants aided by shortages of coal and difficulties in transporting raw materials. The average monthly output—ammonia-soda and natural—for January-August this year was 366,155 tons. This was considerably above the monthly average for any prewar year but was nearly 7 percent below the peak monthly average of 393,203 tons reached in 1944. In the present year production of natural ash has been the highest on record so the falling off has been in the ammonia-soda product.

The highest monthly output of ammonia-soda ash was 399,758 tons in March 1944. This may be taken as an indication of the capacity at that time as operations were reported to be at full capacity rates. In the latter half of 1944 production was on a downward trend but in January 1946 full scale operation was again reported with an output of 387,012 tons which may indicate that plant efficiency fell off more than 12,000 tons a month from the 1944 peak. Again in August, full operation was reported with an output of 364,178 tons which may register a further drop in plant efficiency since the preceding January. While the fall in efficiency may result from the use of over-worked equipment, other factors, such as a higher percentage of unskilled labor, also may contribute.

It has been estimated that the current rate of production falls short by 15 percent of filling essential requirements. This gives proof that present demands for ash are the highest in the history of the industry and that full requirements can not be met without the installation of new capacity. As a first step in that direction, CPA





has approved construction of a new unit at Detroit by Solvay Process Co. at a cost of $460,000 and a similar expenditure by Wyandotte Chemical Corp. for a new unit at Wyandotte, Mich. In the meantime the industry has restored the voluntary distribution plan used during the war. It also has been agreed that the 110,000 tons per year alloted for aluminum will be raised by 45,000 tons. Control over exports likewise has been established.

Average Monthly Production Of Soda Ash

	Total Tons	Ammonia-Soda Tons	Natural Tons
1946 (8 mo.)	366,155	348,738	17,417
1945	379,757	364,585	15,172
1944	393,203	378,208	14,995
1943	380,929	367,302	13,627
1942	327,063	315,715	11,348
1941	308,964	300,569	8,595
1940	263,083	251,250	11,833
1939	246,727	235,652	11,075
1937	253,118	243,222	9,896
1935	209,071	201,141	7,930

The most important change which the war has brought in productive capacity for chemicals is found in the expansion of synthetic nitrogen facilities. Of the 9 government-owned synthetic ammonia plants built during the war, five have been sold or leased to private companies and the additions have more than doubled the synthetic nitrogen capacity of the country.

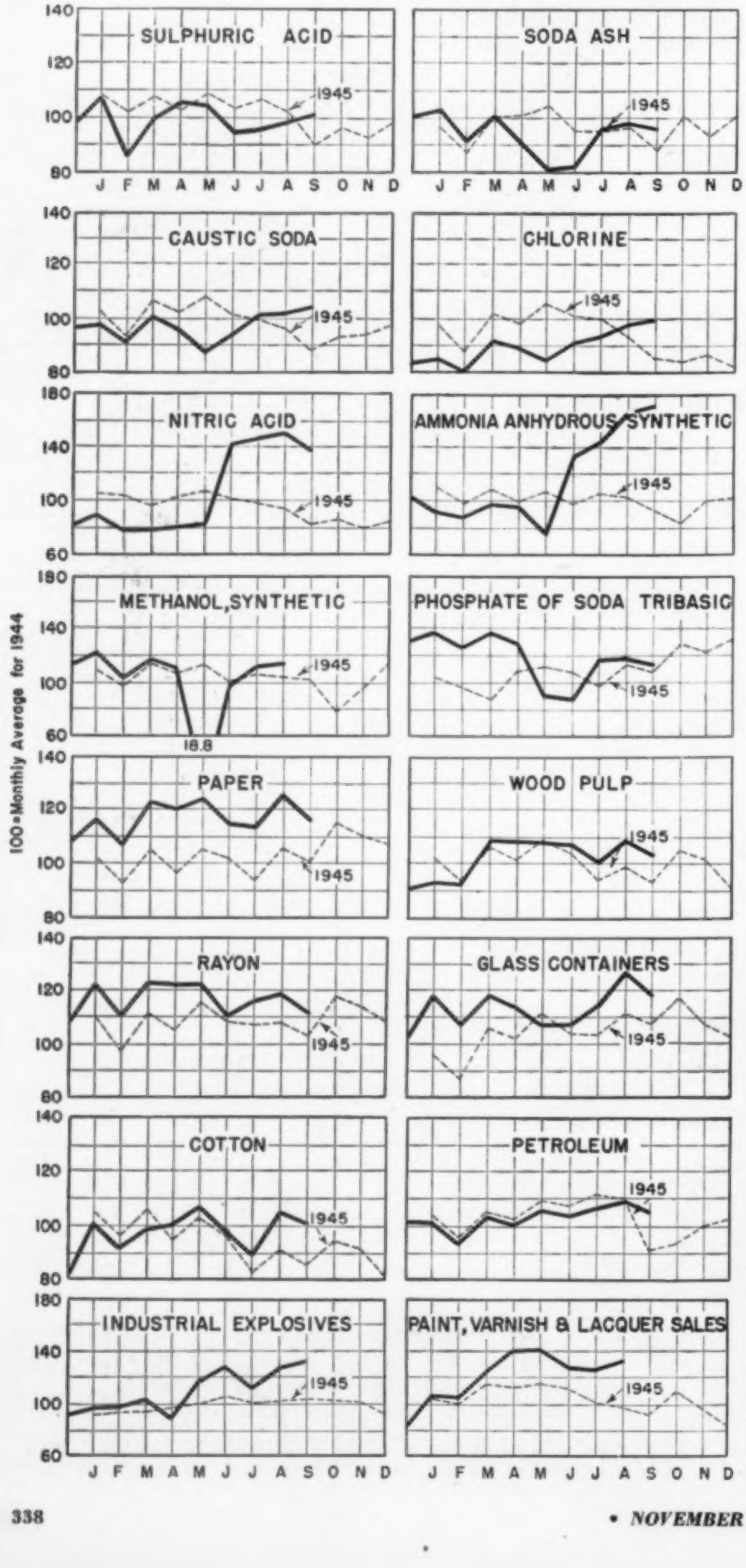
Private Synthetic Nitrogen Rated Capacity

1,000 tons

Owner or Operator	1940*	Nov. 1945*	Sept. 1946
Allied Chemical & Dye Corp.	200.0	208.0	308.0
E. I. du Pont de Nemours & Co.	138.7	168.8	168.8
Shell Union Oil Co.	24.3	24.0	24.0
Hercules Powder Co.	10.0	10.0	10.0
Dow Chemical Co.	8.4	11.3	11.3
Mathieson Alkali Works	4.9	4.0	48.0
Pennsylvania Salt Mfg. Co.	4.0	5.0	5.0
Spencer Chemical Co.	.....	.....	89.0
Lion Oil Co.	.....	.....	89.0
Commercial Solvents Corp.	.....	.....	44.0
Totals	390.3	431.1	797.1

* Source: U. S. Department of Agriculture.

PRODUCTION AND CONSUMPTION TRENDS



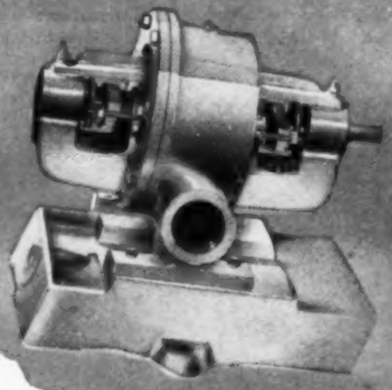
DECONTROL of prices currently is one of the most important factors affecting both values and production trends of chemical products. The effect on production results from an increase in available stocks of scarce materials because of the higher prices they command. Among the materials from which price controls have been removed recently are vegetable tanning materials, vegetable oils and fats, barium chemicals, calcium chloride, furnace carbon blacks, and a long list of petroleum chemicals. The petroleum chemicals thus affected are interpreted to be those of which more than 50 percent of total production is by petroleum refiners, compounders, and blenders. They include synthetic ethyl alcohol, isopropyl alcohol, cresylic acid, phythalic anhydride from xylene, toluol, secondary butyl alcohol, methyl ethyl ketone and several others.

The removal of controls on oils and fats was immediately followed by a sharp rise in prices for most of the products of that industry but the decontrol of chemicals found no general upsurge in sales schedules and where price adjustments were made they were of moderate proportions.

The outlook for larger supplies of pulpwood from Canada has been improved by the removal of price ceilings effective October 31. Paper mills have operated at a very high rate for several months but there always was the possibility that pulpwood supplies would not hold up. In anticipation of this decontrol, sales have been made for some time on an adjustable basis but the situation has been greatly clarified by the OPA action.

The fertilizer industry continues to exert a more than normal influence on the chemical industry in general. Fertilizer tag sales for September were 49 percent above those for September 1945 and the 9-month sales for the 16 reporting states amounted to 7,234,000 tons or 14 percent over the corresponding 1945 period. Demand for fertilizer chemicals not only has influenced the reopening of ammonia plants but has expanded requirements for potash, phosphorus and nitrogen. Production of superphosphates in September was 721,475 tons which is the second highest monthly output on record with the same holding true for consumption of phosphate rock and sulphuric acid. In addition to home requirements, large amounts of fertilizer materials, notably ammonium nitrate and sulphate of ammonia, are exported.

Controls over distribution of certain chemicals still are in effect and are regarded with disfavor because they entail longer freight hauls and greater transportation costs. Recently the industry advisory committee discussed this question with government agencies with particular reference to caustic soda. Producers still make allotments to wartime buyers even though the delivery point is far from the point of production and these customers might be better served by a more favorably situated producer. This condition, however, probably will not change until caustic supplies are brought up to full requirements.



How much does it cost to make a Pump?

It costs a lot of money to make any pump—especially if you want to be a leader, not a follower, and to build a pump so efficient, so dependable that it will be second to none.

You pay the expense of maintaining well-staffed laboratories for product investigation and research—for continuous search for high efficiencies, better applications—and for the thorough testing of your finished product.

You pay the expense of providing production facilities and techniques; you pay for new materials, new methods which, with the cost-reducing benefits of mass production, assure your customers of greatest satisfaction.

Finally, you've the problem of making it easy for your customers to reach you for sales, service and consultation; you must network the country with distribution centers manned by experts.

Yes, all this costs a lot of money. No wonder, then, that there are so few pump manufacturers with this valued background. Among them, Fairbanks-Morse is an unquestioned leader in all phases of liquid-moving service . . . For all pumping problems, first see your Fairbanks-Morse dealer or call at the nearest Fairbanks-Morse branch office.

FAIRBANKS-MORSE

A name worth remembering

United States Production of Certain Chemicals

August 1946, August 1945 and Eight-Month Totals for 1946 and 1945

Chemical and Basis	Units	August 1946	August 1945	Total, 8 Months 1946	Total, 8 Months 1945
Ammonia, synthetic, anhydrous[1]	Tons	75,794	46,787	404,713	376,923
Ammonium nitrate (100% NH_4NO_3)	Tons	77,638	....	400,116	....
Ammonium sulphate, synthetic, technical	M lb.	10,683	....	129,949	....
Calcium arsenate (100% $Ca_3(AsO_4)_2$)	M lb.	8,081	....	28,649	....
Calcium carbide, commercial	Tons	53,399	55,090	351,982	491,360
Calcium phosphate:					
Monobasic (100% $CaH_4(PO_4)_2$)	M lb.	6,738	4,525	46,992	40,016
Dibasic (100% $CaHPO_4$)	M lb.	4,432	5,110	50,103	29,610
Carbon dioxide:					
Liquid and gas	M lb.	24,279	19,704	146,942	144,905
Solid (dry ice)	M lb.	72,292	68,858	442,405	468,414
Chlorine	Tons	102,505	97,695	753,138	826,842
Chrome green (C.P.)	M lb.	1,436	500	12,947	3,805
Chrome yellow and orange (C.P.)	M lb.	3,410	3,275	38,810	26,323
Hydrochloric acid (100% HCl)	Tons	29,519	33,839	218,579	288,292
Hydrogen	M cu. ft.	1,676,000	1,914,000	11,418,000	....
Lead arsenate, acid and basic	M lb.	253	4,723	46,193	56,043
Molybdate chrome orange (C.P.)	M lb.	443	146	3,439	987
Nitric acid (100% HNO_3)	Tons	59,144	37,088	332,258	316,410
Oxygen	M cu. ft.	1,008,061	977,548	14,875,015	10,341,158
Phosphoric acid (50% H_3PO_4)	Tons	74,269	57,952	550,909	453,778
Soda ash (commercial sodium carbonate):					
Ammonia soda process (98–100% Na_2CO_3):					
Total wet and dry[2]	Tons	364,178	363,802	2,780,906	2,925,271
Finished light[3]	Tons	167,983	188,086	1,400,445	1,562,506
Finished dense	Tons	139,678	120,680	996,353	933,799
Natural[4]	Tons	19,250	15,865	139,339	122,882
Sodium bicarbonate, refined	Tons	17,054	14,593	134,566	111,415
Sodium bichromate and chromate	Tons	7,254	6,537	57,982	52,996
Sodium hydroxide (100% NaOH):					
Electrolytic process:					
Liquid[5]	Tons	99,807	92,057	729,610	783,729
Solid	Tons	18,145	17,786	127,907	149,977
Lime soda process:					
Liquid[5]	Tons	63,745	60,261	491,234	492,644
Solid	Tons	20,504	19,947	155,439	161,812
Sodium phosphate:					
Monobasic (100% NaH_2PO_4)	Tons	1,218	1,336	7,740	9,957
Dibasic (100% Na_2HPO_4)	Tons	5,103	5,574	38,162	39,775
Tribasic (100% Na_3PO_4)	Tons	7,958	7,637	64,266	55,748
Meta (100% $NaPO_3$)	Tons	2,373	2,227	18,333	17,694
Tetra (100% $Na_4P_2O_7$)	Tons	4,778	3,905	49,043	26,401
Sodium silicate, anhydrous	Tons	36,915	34,806	269,301	300,427
Sodium sulphate:					
Anhydrous, refined	Tons	10,285	5,717	135,448	51,884
Glaubers salt	Tons	13,209	12,490	118,245	139,064
Salt cake, crude	Tons	43,779	48,974	295,865	....
Sulphuric acid (100% H_2SO_4):[7]					
Contact process, net[6]	Tons	467,750	469,483	3,591,050	3,870,904
Chamber process	Tons	244,874	260,756	1,990,447	2,145,695
Zinc yellow	Tons	2,216	1,159	....	12,251

Data for this tabulation have been taken from "Facts for Industry" series issued by Bureau of the Census and WPB Chemical Bureau. Production figures represent primary production and do not include purchased or transferred materials. Quantities produced by government-owned arsenals, ordnance works, and certain plants operated for the government by private industry are not included. Chemicals manufactured by TVA, however, are included. All tons are 2,000 lb. Where no figures are given, data are either confidential or not yet available. [1] Includes a small amount of aqua ammonia. [2] Total wet and dry production, including quantities diverted for manufacture of caustic soda and sodium bicarbonate, and quantities processed to finished light and finished dense. [3] Not including quantities converted to finished dense. [4] Data collected in cooperation with the Bureau of Mines. [5] Figures represent total production of liquid material, including quantities evaporated to solid caustic and reported as such. [6] Includes oleum grades, excludes spent acid. [7] Data for sulphuric acid manufactured as a byproduct of smelting operations are included.

United States Production of Certain Synthetic Organic Chemicals

July 1946, July 1945 and Seven-Month Totals for 1946 and 1945

Chemicals	July 1946	July 1945	Total, 7 Months 1946	Total, 7 Months 1945
Acetic acid:				
Synthetic[1]	23,907,485	20,459,033	157,243,691	162,345,956
Recovered[2,3]	99,522,121	....	671,431,383	....
Natural	2,423,495	2,806,968	15,226,625	20,825,769
Acetic anhydride[4]	44,520,734	43,866,916	300,703,919	316,667,234
Acetone	24,666,012	....	185,447,727	....

(Continued on page 348)

U. S. Production of Synthetic Organic Chemicals (Cont. from page 340)

Chemicals	July 1946	July 1945	Total, 7 Months 1946	Total, 7 Months 1945
Acetylsalicylic acid	572,337	813,540	6,133,980	6,196,165
Aniline	8,213,302	....	49,630,831	....
Barbituric acid derivatives:[5]				
5-Ethyl-5-Phenylbarbituric acid and salts (Phenobarbital)	38,331	24,442	233,715	170,027
Benzene:				
Motor grade:				
Tar distillers[4]	502,580	....	5,878,385	....
Coke-oven operators[6]	3,134,602	....	16,915,257	....
All other grades:				
Tar distillers[4]	1,381,563	....	13,485,968	....
Coke-oven operators[6]	9,660,166	....	143,099,456	....
Buytl alcohol, primary, normal	8,303,378	....	137,321,771	....
Carbon bisulphide	23,360,877	....	169,962,214	....
Carbon tetrachloride	10,674,553	....	79,184,839	....
Chlorobenzene, mono	20,887,731	....	154,786,586	....
Creosote oil:				
Tar distillers	8,623,813	9,840,860	63,410,035	77,196,867
Coke-oven operators	2,616,423	3,051,086	13,330,262	21,768,001
Cresols[7]:				
Meta-para	536,301	544,690	2,602,862	4,506,548
Ortho-meta-para	1,063,308	813,723	....	....
Cresylic acid, refined[7]	2,180,642	2,375,299	12,470,554	17,440,024
Dibutyl phthalate	1,118,944	....	....	....
Dichlorodiphenyltrichloroethane (DDT)	3,573,122	....	25,426,428	....
Ethyl acetate (85 percent by wt.)	9,877,090	9,455,760	51,792,265	64,497,550
Ethyl ether, technical and U.S.P.	3,448,050	7,223,495	20,704,437	54,992,768
Formaldehyde (37 percent by wt.)	38,094,994	....	162,404,221	....
Methanol:				
Natural	1,326,054	[9] 1,537,800	9,193,597	[9] 11,407,49[illegible]
Synthetic	44,841,123	41,951,520	271,267,760	295,453,440
Naphthalene:				
Tar distillers (Less than 79° C.)[4]	17,505,571	17,014,259	102,709,008	117,603,097
Tar distillers (79° C. and over)[4]	7,372,432	6,685,383	55,726,247	41,517,645
Coke-oven operators (Less than 79° C.)[6]	7,316,084	7,715,663	33,518,022	53,034,951
Penicillin[5]	2,292,287	....	14,783,755	....
Phenol, synthetic and natural	13,492,879	....	114,317,441	....
Phthalic anhydride	8,921,278	10,934,029	60,037,291	77,959,479
Styrene (Government owned plants only)	32,835,374	....	216,803,308	....
Toluene:				
Coke-oven operators[6]	1,397,822	....	9,249,671	....
All other[8, 10]	1,050,287	....	7,625,111	....

All data in pounds except benzene (gal.), creosote oil (gal.), toluene (gal.), and penicillin (million Oxford units). Statistics collected and compiled by U. S. Tariff Commission except where noted. Absence of data on production indicates either that returns were unavailable or confidential. [1] Excludes the statistics on recovered acid. [2] Acid produced by direct process from wood and from calcium acetate. [3] All acetic anhydride including that from acetate acid by vapor-phase process. [4] Product of distillers who use purchased coal tar only. [5] Statistics are given in terms of bulk medicinals only. [6] Statistics collected by Bureau of Mines. [7] Total production including data reported both by coke-oven operators and by distillers of purchased coal tar. [8] Reported to U. S. Bureau of the Census. [9] Reported in gal. by Bureau of the Census but converted to lb. for comparison with the production of synthetic methanol. [10] Includes toluene produced from petroleum by any process.

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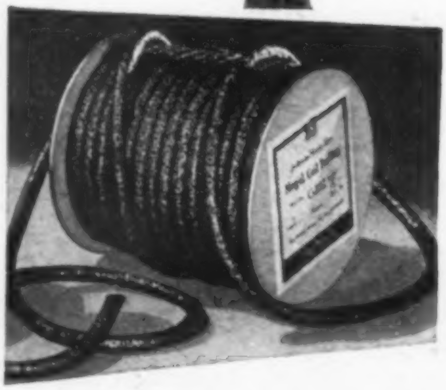

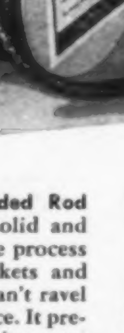

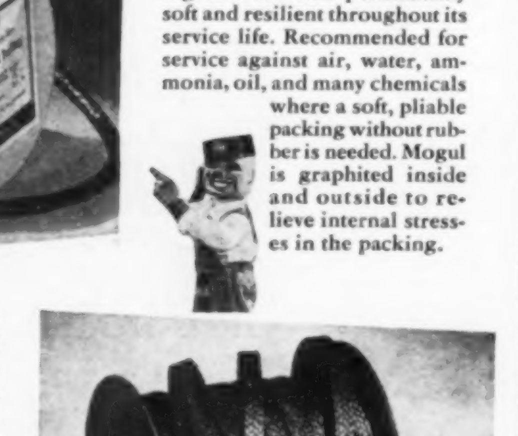

CHEMICAL ENGINEERING Weighted Index of Prices for CHEMICALS

Base = 100 for 1937

This month	112.66
Last month	111.82
November, 1945	108.78
November, 1944	108.81

CURRENT PRICES

The accompanying prices refer to round lots. Where it is trade custom to sell f.o.b. works, quotations are so designated. Prices are corrected to November 11

INDUSTRIAL CHEMICALS

Acetone, tank, lb.	$0.07 –.......
Acid, acetic, 29% bbl., 100 lb.	3.38 – $3.63
Boric, bbl., ton	109.00 –113.00
Citric, drums, lb.	.22½– .23
Formic, cbys., lb.	.10½ .11
Hydrofluoric, 30%, drums, lb.	.08 – .085
Lactic, 44% tech., light, bbl., lb.	.073– .075
Muriatic, 18°, tanks, 100 lb.	1.05 –.......
Nitric, 36°, carboys, lb.	.05 – .02½
Oleum, tanks, wks., ton	18.50 – 20.00
Oxalic, crystals, bbl., lb.	.11½– .12½
Phosphoric tech., tanks, lb.	.04 –.......
Sulphuric, 60°, tanks, ton	13.00 –.......
Tartaric, powd., bbl., lb.	.54½– .56
Alcohol, amyl from pentane, tanks, lb.	.131–.......
Alcohol, butyl, tanks, lb.	.14½– .25
Alcohol, ethyl, denatured, No. 1 special, tanks, gal.	.542–.......
Alum, ammonia, lump, lb.	.04½–.......
Aluminum sulphate, com. bags, 100 lb.	1.15 – 1.45
Ammonia, anhydrous, cyl., lb.	.14½–.......
tanks, ton	59.00 – 61.50
Ammonium carbonate, powd., casks, lb.	.09½– .10
Sulphate, wks., ton	30.00 –.......
Amyl acetate, tech. from pentane, tanks, lb.	.181–.......
Aqua ammonia, 26°, drums, lb.	.02½– .03
tanks, ton	65.00 –.......
Arsenic, white, powd., bbl., lb.	.05 – .05½
Barium carbonate, bbl., ton	65.00 – 75.00
Chloride, bbl., ton	75.00 – 78.00
Nitrate, casks, lb.	.09½– .11
Blanc fixe, dry, bags, ton	60.00 – 70.00
Bleaching powder, f.o.b., wks., drums, 100 lb.	2.50 – 3.00
Borax, gran., bags, 100 lb.	45.00 –.......
Calcium acetate, bags, 100 lb.	3.00 –.......
Arsenate, dr., lb.	.07½– .08
Carbide, drums, ton	50.00 –.......
Chloride, flake, bags, del., ton	18.50 – 25.00
Carbon bisulphide, drums, lb.	.05 – .05
Tetrachloride, drums, gal.	.73 – .80
Chlorine, liquid, tanks, wks., 100 lb.	1.83½– 2.10
Copperas, bgs., f.o.b., wks., ton	17.00 – 18.00
Copper carbonate, bbl., lb.	.19½– .20
Sulphate, bbl., 100 lb.	5.65 – 6.15
Cream of tartar, bbl., lb.	.45 – .50
Diethylene glycol, dr. lb.	.14½– .15½
Epsom salt, dom., tech., bbl., 100 lb.	1.80 – 2.00
Ethyl acetate, tanks, lb.	.08½– .11½
Formaldehyde, 30%, tanks, lb. wks.	.032–.......
Furfural, tanks, lb.	.09½–.......
Glaubers salt, bags, 100 lb.	1.05 – 1.10
Glycerine c.p. drums, extra, lb.	.18½– .19
Lead:	
White, basic carbonate, dry, casks, lb.	.10 –.......
Red, dry, sck., lb.	.10½–.......
Lead acetate, white crys., bbl., lb.	.12½– .13
Arsenate, powd., bags, lb.	.13½– .14½
Lithopone, bags, lb.	.044– .049
Magnesium, carb., tech., bags, lb.	.07½– .08
Methanol, 95%, tanks, gal.	.60 –.......
Synthetic, tanks, gal.	.24 –.......
Phosphorus, yellow, cases, lb.	.23 – .25
Potassium bichromate, bags, lb.	.10 – .10½
Chlorate, powd., lb.	.09½– .12
Hydroxide (c'stic potash) dr., lb.	.07 – .07½
Muriate, 60%, bags, unit	.53½–.......
Nitrate, ref., bbl., lb.	.08 – .09
Permanganate, drums, lb.	.19½– .20
Prussiate, yellow, casks, lb.	.16 – .17
Sal ammoniac, white, casks, 100 lb	4.50 – 5.00
Salsoda, bbl., 100 lb.	1.00 – 1.05
Salt cake, bulk, ton	15.00 –.......
Soda ash, light, 58%, bags, contract, 100 lb.	1.10½–.......
Dense, bags, 100 lb.	1.20½–.......
Soda, caustic, 76% solid, drums, 100 lb.	2.41½– 3.15
Acetate, del., bbl., lb.	.05½– .06
Bicarbonate, bbl., 100 lb.	1.70 – 2.00
Bichromate, bags, lb.	.07½– .08
Bisulphate, bulk, ton	16.00 – 17.00
Bisulphite, bbl., lb.	.03 – .04

CHEMICAL ENGINEERING
Weighted Index of Prices for
OILS & FATS

Base = 100 for 1937

This month	286.77
Last month	161.52
November, 1945	145.63
November, 1944	145.56

Chlorate, kegs, lb.	$0.06½ –	$0.06½
Cyanide, cases, dom., lb.	.14½ –	.15
Fluoride, bbl., lb.	.07 –	.08
Hyposulphite, bags, 100 lb.	2.25 –	2.50
Metasilicate, bbl., 100 lb.	3.40 –	4.00
Nitrate, bulk, ton	27.00 –	....
Nitrite, casks, lb.	.06½ –	.07
Phosphate, tribasic, bags, 100 lb.	2.70 –	....
Prussiate, yel., bags, lb.	.10½ –	.11
Silicate, 40°, dr., wks., 100 lb.	.80 –	.85
Sulphite, crys., bbl., lb.	.02½ –	.02½
Sulphur, crude at mine, long ton	16.00 –	....
Dioxide, cyl., lb.	.07 –	.08
Dioxide, tanks, lb.	.04 –	....
Tin crystals, bbl., lb.	.39½ –	....
Zinc chloride, grains, bbl., lb.	.05½ –	.06
Oxide, lead free, bags, lb.	.08 –	.08½
Oxide, 5% leaded, bags, lb.	.08 –	.08½
Sulphate, bbl., cwt.	3.85 –	4.00
OILS AND FATS		
Castor oil, No. 3 dr., lb.	$0.29 –	$0.30
Chinawood, oil, tanks, lb.	.39 –	....
Coconut oil, ceylon, N. Y., lb.	.24 –	....
Corn oil crude, tanks (f.o.b. mill), lb.	.26 –	....
Cottonseed oil crude (f.o.b. mill), tanks, lb.	.26 –	....
Linseed oil raw, car lots, dr., lb.	.353 –	....
Palm, casks, lb.	nom.	
Peanut oil, crude, tanks (mill), lb.	.26 –	....
Rapeseed oil, refined, bbl., lb.	nom.	
Soybean, tanks, lb.	.23 –	....
Menhaden, light, pressed, dr., lb.	nom.	
Crude, tanks (f.o.b. factory), lb.	.21½ –	....
Grease, yellow, loose, lb.	.21½ –	....
Oleo stearine, lb.	nom.	
Oleo oil, No. 1, lb.	.38 –	....
Red oil, distilled, bbl., lb.	.29 –	....
Tallow, extra, loose, lb.	.19½ –	....
COAL TAR PRODUCTS		
Alpha-naphthol, crude, bbl., lb.	$0.52 –	$0.55
Alpha-naphthylamine, bbl., lb.	.32 –	.34
Aniline oil, drums, lb.	.11½ –	.12½
Aniline salts, bbl., lb.	.22 –	.24
Benzaldehyde, tech., dr., lb.	.25 –	.50
Benzidine base, bbl., lb.	.70 –	.75
Benzoic acid, USP, kegs, lb.	.54 –	.56
Benzol, 90%, tanks, works, gal.	.15 –	....
Benzyl chloride, tech., dr., lb.	.22 –	.24
Beta-naphthol, tech., drums, lb.	.21 –	.22
Cresol, USP, dr., lb.	.11½ –	....
Cresylic acid, dr., wks., gal.	.81 –	.83
Diphenyl, bbl., lb.	.15 –	....
Diethylaniline, dr., lb.	.40 –	.45
Dinitrotoluol, bbl., lb.	.18 –	.19
Dinitrophenyl, bbl., lb.	.22 –	.23
Dip oil, 15%, dr., gal.	.23 –	.25
Diphenylamine, dr., f.o.b. wks., lb.	.25 –	....
H acid, bbl., lb.	.45 –	.50
Hydroquinone, bbl., lb.	.90 –	....
Naphthalene, flake, bbl., lb.	.09½ –	.10
Nitrobenzene, dr., lb.	.08 –	.09
Para-cresol, bbl., lb.	.41 –	....
Para-nitroaniline, bbl., lb.	.42 –	.43
Phenol, USP, tanks, lb.	.10 –	.11
Picric, acid, bbl., lb.	.35 –	.40
Pyridine, dr., gal.	1.55 –	1.60
Resorcinol, tech., kegs, lb.	.65 –	.70
Salicylic acid, tech., bbl., lb.	.26 –	.33
Solvent naphtha, w.w., tanks, gal.	.26 –	....
Toluidin, bbl., lb.	.96 –	....
Toluol, drums, works, gal.	.27 –	....
Xylol, com., tanks, gal.	.22 –	....
MISCELLANEOUS		
Casein, tech, bbl., lb.	nom.	
Dry colors:		
Carbon gas, black (wks.), lb.	$.0365 –	.097
Prussian blue, bbl., lb.	.36 –	.37
Ultramarine blue, bbl., lb.	.11 –	.26
Chrome green, bbl., lb.	.24 –	.33
Carmine, red, tins, lb.	5.50 –	6.00
Para toner, lb.	.75 –	.80
Vermilion, English, bbl., lb.	2.50 –	2.60
Chrome yellow, C.P., bbl., lb.	.17 –	.18
Gum copal, Congo, bags, lb.	.09 –	.55
Manila, bags, lb.	.09 –	.15
Damar, Batavia, cases, lb.	.10 –	.22
Kauri, cases, lb.	.18 –	.60
Magnesite, calc., ton	64.00 –	....
Pumice stone, lump, bbl., lb.	.05 –	.07
Rosin, H., 100 lb.	8.77 –	....
Shellac, orange, fine, bags, lb.	.72 –	....
Bleached, bonedry, bags, lb.	.71 –	....
T. N. bags, lb.	.67 –	....
Turpentine, gal.	1.16 –	....

NEW CONSTRUCTION

	Current Projects Proposed Work	Current Projects Contracts	Cumulative 1946 Proposed Work	Cumulative 1946 Contracts
New England	$...........	$55,000	$1,165,000	$7,314,000
Middle Atlantic	....	55,000	26,096,000	34,490,000
South	5,135,000	26,138,000	66,177,000	119,713,000
Middle West	700,000	532,000	16,339,000	74,752,000
West of Mississippi	375,000	28,800,000	99,830,000	152,109,000
Far West	1,000,000	268,000	13,055,000	31,485,000
Canada	1,365,000	2,440,000	1,770,000	18,233,000
Total	$8,575,000	$58,288,000	$224,432,000	$438,096,000

PROPOSED WORK

Calif., Glendale—Lambert Pharmacal Co., 1608 East 15th St., Los Angeles, plans to construct a research and administration building on Verdugo Rd. near Indian Springs. Estimated cost $1,000,000.

Fla., Panama City—International Paper Co., Southern Kraft Div., Panama City, plans to construct a soda recovery unit. Estimated cost $80,000.

La., Gretna—Southern Cotton Oil Co., Gretna, plans to construct a 4 story refinery. Estimated cost $55,000.

Mich., Sheboygan—Paper Corporation of America, Sheboygan, plans to construct an addition to its paper mill. Estimated cost $300,000.

O., Shawnee—Claycraft Brick Co., Shawnee, plans to enlarge its plant. Estimated cost $400,000.

Tex., Borger—Phillips Petroleum Co., Borger, plans to reconstruct portion of its plant recently destroyed by fire. Estimated cost $100,000.

Tex., Houston—Atlas Mineral Products Co. of Texas, Old Liberty Rd., plans to construct a new plant for producing sulphur cement, etc. Estimated cost $150,000.

Tex., Houston—Southern Acid & Sulphur Co., LaPorte Rd., plans to construct an addition to its existing ammonium phosphate fertilizer plant. Estimated cost $125,000.

Va., Waynesboro—E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., plant to construct an addition to its rayon plant here. Estimated cost $5,000,000.

B. C., Vancouver—British Columbia Pulp & Paper Co., Ltd., Vancouver, plans to construct a steam plant at its wood fibre plant here. Estimated cost $100,000.

Ont., Hamilton—Canadian Industries, Ltd., 1135 Beaver Hall Hill, Montreal, Que., plans to construct an addition to its plant here. Estimated cost $1,000,000.

Ont., Hamilton—World Plastics Corp., Hamilton, plans to construct a factory. Estimated cost $55,000.

Ont., Toronto—Comet Cigarette Paper Co. of Canada, Ltd., 15 Toronto St., plans to construct a factory. Estimated cost $60,000.

Ont., Toronto—Slick Glass Co., Gas City, Ind., plans to construct a factory here. Estimated cost $90,000.

Que., Montreal—Gamlen Chemical Co. of Canada, Ltd., 57 West St. James St., plans to construct a plant. Estimated cost $60,000.

CONTRACTS AWARDED

Conn., Norwalk—Norwalk Tire & Rubber Co., Winnepauk St., has awarded the contract for the construction of a 2 story, 80x90 ft. plant on Belden Hill Rd., to W. J. Lyons, 9 Mechanic St. Estimated cost $55,000.

Del., Wilmington—E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., will construct a chemical manufacturing plant at Edgemoor, with own forces. Estimated cost $114,700.

Fla., Jacksonville—Wilson & Toomer Fertilizer Co., Talleyrand Ave., has awarded the contract for a sulphuric acid manufacturing plant to George D. Auchter Co., foot of East 56th St. Estimated cost $300,000.

Ill., Chicago—Globe Roofing Products, 2211 Schrage St., Whiting, Ind., has awarded the contract for a 1 story, 75x400 ft. felt mill to Paul Schwendener, 7553 South Chicago St., Chicago. Estimated cost $150,000.

Ill., North Chicago—Abbott Laboratories, 1400 Sheridan St., has awarded the contract for a 1 and 2 story, 90x180 ft. brick fermentation building and connecting tunnel, to Carroll Construction Co., 333 North Michigan Ave., Chicago, at $382,000.

Mo., St. Louis—Mallinckrodt Chemical Works, 3600 North Second St., has awarded the contract for altering its warehouse to Dickie Construction Co., Loudermann Bldg. Estimated cost $60,000.

Mo., St. Louis—Standard Oil Co., 910 South Michigan Ave., Chicago, Ill., has awarded the contract for a 1 story engineering and research building, 100 octane cracking plant, etc., at Sugar Creek to Stone & Webster Corp., 33 South Clark St., Chicago. Estimated cost including equipment $20,000,000.

N. C., Old Fort—United Rayon Mills, Old Fort, have awarded the contract for a rayon knitting plant to Potter & Shackleford, Greenville, S. C. Estimated cost $88,000.

Pa., Philadelphia—Kessler Chemical Co., Inc., State and Cottman Sts., has awarded the contract for a 1 story, 40x121 ft. storage building to Edgar M. Wamboldt, 201 North Broad St. Estimated cost $55,000.

S. C., Charleston—American Agricultural Chemical Co., 50 Church St., New York, N. Y., will construct an addition to its sulphuric acid plant here. Work will be done with own forces. Estimated cost $60,000.

Tenn., Chattanooga—Lockout Oil & Refining Co., Kirkland Ave., will alter its plant and warehouse using day labor. Estimated cost $75,000.

Tenn., Morristown—American Enka Corp., Asheville, N. C., has awarded the contract for the design and construction of a synthetic yarn plant to H. K. Ferguson Co., 1650 Hanna Bldg., Cleveland, O. Estimated cost $20,000,000.

Tex., Houston—Diamond Alkali Co., Oliver Bldg., Pittsburgh, Pa., has awarded the contract for design and construction of chemical plant units to Brown & Root, Inc., Route 3. Estimated cost $240,000.

Tex., Houston—Shell Oil Co., Inc., Shell Bldg., has awarded the contract for enlarging its plant to C. F. Braun & Co., Nils Esperson Bldg. Estimated cost $2,500,000.

Tex., Pasadena—Champion Paper & Fibre Co., Pasadena, has awarded the contract for altering, improving and construction addition to paper manufacturing plant to Ebasco Service, Inc., Pasadena. Estimated cost $2,900,000.

Tex., Texas City—Monsanto Chemical Co., Texas City, has awarded the contract for constructing a polystyrene plant and converting present plant for the manufacture of styrene to W. S. Bellows Construction Co., 716 North Everton St., Houston. Estimated cost $2,600,000 and $500,000 respectively.

Wash., Seattle—The Texas Co., 135 East 42nd St., New York, N. Y., will construct an oil storage and distribution plant on Harbor Island. Work will be done by day labor. Estimated cost $268,020.

W. Va., Parkersburg—American Cyanamid Co., Calco Chemical Div., 30 Rockefeller Plaza, New York, N. Y., has awarded the contract for a 1 and 2 story manufacturing plant and warehouse at Willow Island, near here, to Turner Construction Co., 420 Lexington Ave., New York, at $3,500,000; chemical plant equipment to Rust Engineering Co., Clark Bldg., Pittsburgh, Pa., at $2,000,000.

Ont., Toronto—Abitibi Power & Paper Co., Ltd., 408 University Ave., Toronto, has awarded the contract for an addition to its plant to Piggott Construction Co., Ltd., Harbour Commission Bldg. Estimated cost $75,000.

Ont., Toronto—McColl-Frontenac Oil Co., Yardley Bldg., has awarded the contract for a grease and lubrication plant to Foundation Co. of Ontario, Ltd., 1220 Bay St. Estimated cost $430,000.

Que., Sorel—Canadian Celanese Ltd., 1401 McGill College Ave., Montreal, has awarded the contract for a plant building to Marine Industries, Ltd., 174 du Roi St., Sorel. Estimated cost $1,000,000.

Que., Valleyfield—Merck & Co., Ltd., 560 de Courcelleo St., Montreal, has awarded the contract for an addition to its processing plant at Grand Isle to Raphael Belanger, 47 Jacques Cartier St., Valleyfield. Estimated cost $85,000.

Que., Ville La Salle—Dominion Tar & Chemical Co., 2220 Sun Life Bldg., Montreal, has awarded the contract for a warehouse and specialty building to J. L. Heuson, Ltd., 660 St. Catherine St., W., Montreal. Estimated cost $250,000.

Que, Ville La Salle—Montreal Coke & Manufacturing Co., Ltd., 435 St. Patrick St., has awarded the contract for an addition to its plant to By-Product Coke Co. of Canada, Ltd., P. O. Box 6110, Montreal. Estimated cost $600,000.